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**81st SMPTE Convention • Apr. 29–May 3, 1957 • Shoreham Hotel, Washington**

**volume 66 • number 2** **FEBRUARY 1957**

# JOURNAL of the SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

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Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879, and published monthly.


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Printed by Mack Printing Company, Easton, Pa.

Journal of the Society of Motion Picture and Television Engineers

VOLUME 66 • NUMBER 2 • FEBRUARY 1957

# Developmental Possibilities in 16mm Projectors

By JOHN A. MAURER

**This paper adumbrates the possibilities of 16mm film and describes the objectives of projector design. It is stated that 16mm films are, at present, capable of approximating 35mm picture and sound quality. The JAN-Spec projector is described and the possibility of developing a portable system capable of obtaining full quality performance from 16mm film is discussed.**

WHAT we attempt to accomplish in the development of any piece of equipment is determined in large part by what we believe to be possible. The significance of this statement will be made clear, I hope, by the following further observation: It is not likely that any designers are working at the present time on theater projectors for 8mm film.

In the 16mm field it is my belief that we have been limited in our aims and objectives, and consequently also in our accomplishments, by too pessimistic a view of what can be accomplished with 16mm film. It is true, unfortunately, that many exhibitions with 16mm film are of mediocre to poor quality in both picture and sound. This is bound to happen in a field in which much equipment survives from an earlier era and in which many workers are rank amateurs or beginners, uninformed about the finer points of procedure which the professional should know and observe. The trouble is that the experience of poor performance leads to the impression that really good performance is impossible; to a defeatist attitude that says, "Well, after all, what can you expect? It's only 16mm!" This attitude is particularly likely to affect business executives in the industry who decide how often and how diligently we attempt to make improvements.

The military services deserve a great deal of credit for having taken the initiative in encouraging the development of projectors with which, given good film, it is possible to approximate closely the performance normally given by 35mm film and equipment. I refer, of course, to the well known JAN-Spec projector and to the program by the Navy which resulted in the demonstration given in Washington, in May 1954,* of a portable projector equipped with a xenon arclamp which delivered more than 2000 lumens to the screen, giving an 18-ft picture with standard screen brightness. These developments and the parallel development of what is essentially a 16mm theater projector by one large manufacturer have done a great deal to open the eyes of the industry to what can be accomplished with 16mm film in our present state of knowledge.

What we accomplish in the commercial production of films is, of course, only a fraction of what we know how to do. Nevertheless, what is done in the scientific laboratory today is the commercial practice of tomorrow or, at the latest, of day after tomorrow, and this must be taken into account in the engineering of related products, such as the projector.

I have been invited, on this occasion, to indicate what should be the objectives of projector design for the possibilities of day after tomorrow. I propose to begin by setting forth what can be done in film production with the knowledge available today.

The statement is often made, and very commonly believed, that modern photographic lenses, in their ability to form images of fine detail, far surpass the ability of the photographic film to record that detail. If this were true in the sense in which it is stated, it would mean that 16mm film could not possibly rival the pictorial performance of 35mm and wider films, since the amount of detail in the picture would be proportional to the area of the frame. What is actually true, however, is that only in the 8mm size does the lens approximate a "perfect" imaging system.

In both the 16mm and 35mm sizes the aberrations of the lens limit the performance at least as much as the film. This means that if we employ the top-quality lenses available today we can come close to recording as much detail on 16mm film as is normally done on 35mm. Because the 16mm lenses are of shorter focal lengths they behave more nearly like "perfect" lenses, and this makes it possible to use more of the ability of the film to record detail in 16mm. We see the same optical laws at work on the pages of magazines such as *Life* and *Look*, which today derive most of their illustrations, even up to the full-page size, from "miniature" camera negatives.

Putting what has been expressed in quantitative form, it may be stated that, with top-quality lenses on a professional type of camera, we can expect to obtain resolution of 60 to 70 lines/mm on original films and, after printing on good step printers, 45 to 55 lines/mm in the print. The lower figures apply to color films.

In 35mm practice it was found by the Television Committee of this Society a few years ago that resolution of 28 lines/mm gives a picture that appears sharp even from the front row of seats in the average theater. Since the linear sizes of the two frames are very nearly in a two-to-one ratio, this means that the 16mm film must resolve 56 lines/mm to give equivalent performance. With the best lenses and suitable films, this figure is approached closely in the black-and-white 16mm release print. In color there is some sacrifice of resolution, but the film types most recently introduced to the market show great improvement in sharpness and, I believe, make it per-

* Three papers in *Jour. SMPTE, 63:* 95–104, Sept. 1954: Philip M. Cowett, "Navy development program for a brighter projector light source"; William T. Anderson, Jr., "High-brightness xenon compact arclamp"; and Ellis W. D'Arcy and Anton C. Seda, "Applications of the xenon arc to the Armed Forces 16mm Projector."

Presented on October 22, 1956, at the meeting of the Society's Washington Section by John A. Maurer, JM Developments, Inc., 116 W. 29 St., New York 1.
(This paper was received on November 29, 1956.)

missible to expect, in another year or two, 16mm color as well as black-and-white prints with definition equivalent to 35mm.

Good pictorial performance also requires excellent picture steadiness. For some years, the standards adopted by the Society have given a maximum picture jump of $\frac{1}{4}$ of 1% of the picture width as an acceptable standard of steadiness. This applies both to 35mm and 16mm screen images. In 16mm this allows essentially 0.001 in. of jump at the film as the accumulated result of inaccuracy of the perforations of the two films, inaccuracy of register in the camera, jump resulting from printing and jump due to the projector. Each of these contributions at the present time, with the best equipment, is in the range from 0.0001 to 0.0002 in., so that the accumulated jump rarely amounts to as much as 0.001 in. On this score, therefore, there is no reason to avoid the projection of theater-size pictures from 16mm film.

For any given film size and any type of light source, there is a practical maximum amount of light that can be directed upon the film at the gate without damaging the film during the brief time that it is in the gate. This limit is not reached in the JAN-Spec projector with the 1000-w incandescent lamp delivering 525 lm to the screen. It is approached in a carbon arclamp projector delivering 2500 lm. In order to reach this value safely, it was found necessary to use heat-absorbing glass in the illuminating system and provide an air stream to keep the film and gate cool. The experimental xenon arclamp installation in a JAN-Spec projector did not appear to need special cooling devices while delivering 2200 lm. This indicates that this type of source has a favorable ratio of infrared to visible radiation. We may conclude that the 16-mm film frame is not too small to transmit enough light for theater-size pictures.

### Sound Quality

It is not generally believed that it is possible to obtain sound quality comparable to normal 35mm photographic sound on 16mm film. Actually, normal 35mm recording practice is so far from utilizing the full capabilities of the photographic emulsion that it is fairly easy to obtain the customary standard of performance with 16mm film provided a suitable reproducer is used. If the 16mm methods were applied to 35mm film they would produce records "flat" to at least 20,000 cycles, with signal-to-noise ratio of at least 60 db.

At the convention of this Society at Lake Placid in the Fall of 1950 I demonstrated 16mm records flat to 10,000 cycles with low distortion and with signal-to-noise ratios of 45 db. These were "direct positive" variable-density records produced by a recording system which gives an accurately controlled nonlinear modulation of the light beam in such a way as to pre-compensate for the nonlinearity of the photographic process. Subsequent work improved the signal-to-noise ratio until it is now in the range of 52 to 55 db. The range of modulation obtained is from 5% to 85% light transmission, which gives a reproduction level much higher than that of most variable-density, equal to that of good variable-area records. This process has been in commercial use in New York for the past several years in connection with television. The sound record master is a magnetic record on 16mm film base. Quality has been limited as much by the magnetic record as by the photographic recording process; it was proved repeatedly that if the photographic release print and the magnetic record from which it was recorded were run simultaneously in synchronism on the best available reproducers, it was impossible to distinguish between them when switching back and forth.

Still later work on reversal color duplicating films yielded particularly fine quality. The frequency range was not as wide as in black-and-white, but a flat 6000-c range was obtained without difficulty, and the records were particularly low in distortion and in background noise. Unfortunately, this work was done with the now discontinued type of color stock, so that the measurement and adjustment procedure must be repeated with the present film before it will be commercially significant. The point to be remembered, however, is that it has been proved that the same kind of sound quality to which we have been accustomed in theatrical motion pictures can be obtained on 16mm color prints.

I have spoken of my own work in 16mm sound because these are the results with which I am most familiar. What one organization has been able to accomplish, other competent engineering groups should be able to do with no great difficulty.

*To summarize:* It can be stated with assurance that if 16mm films are produced by competent workers using the best techniques *now* available, they are capable of yielding results that closely approach those of current 35mm releases in picture and sound quality. Also, projection on theater-size screens is possible without damage by overheating of the film.

### Portable-Projector Design

Can this result be obtained with a portable projector? I believe that it can; and I shall indicate how I believe such a development should proceed.

The rational design of a projector begins with the choice of the light source. The dimensions of the light source, the dimensions of its glass or quartz envelope, and its cooling requirements will impose certain limitations on the optical system, that is, on the condenser and the projection lens. These must be designed to give as high efficiency as is possible consistent with whatever standard of uniformity of screen illumination has been adopted. Illumination of 75% in the corners of the screen as compared with 100% in the center is generally a reasonable requirement.

Since we know that the incandescent type of lamp cannot be made to give much more than the 525 lm obtained with the present JAN-Spec projector, we must look to light sources of greater brightness in order to obtain the 2000 or more lumens needed for theater-sized screens. The possible choices are the carbon arc, the zirconium arc, and the xenon short arc. The carbon arclamp is large; it is not suitable for use outside a separate enclosed projection room; also it requires a certain skill for its operation. For these reasons, it may be ruled out for portable equipment. Of the other two possibilities the xenon arc appears to be much better suited for this type of service. It is a gaseous discharge under high pressure in a comparatively small quartz tube; the light has a continuous spectrum of quality very similar to sunlight. The lamp is somewhat costly, but has a long life, of the order of 300 to 400 hr. There is some prospect that further development work will increase the life expectancy to as much as 1000 hr.

The biplane filament array of the familiar 1000-w incandescent lamp is approximately 11 mm square. The light source in the xenon short arclamp is much smaller. In various lamps of 500- to 2000-w power consumption it varies from about 2 mm square to 3 mm square, and in one case it measures approximately 2 × 4 mm. This small source calls for a condensing lens system quite different from those to which we have been accustomed. It also has interesting implications with reference to projection lens design.

It can be proved, although I shall not try to do so here, that any moderately small light source is utilized at maximum efficiency if we place it as close to the film aperture as possible, allowing room between the bulb and the aperture only for the shutter (if one is used), and for a condensing lens or lenses which will image the source in the entrance pupil of the projection lens. Longer optical trains, if properly designed, can equal but cannot exceed the screen brightness that will be obtained with the system described.

With the compact type of condensing lens system the size of the light beam when it reaches the projection lens depends on the source size; if the source is large enough, the projection lens will be filled with light; if it is small, only the center of the lens aperture will be used. Thus the incandescent type of lamp is capable of filling a lens having an aperture as great as $f/1.4$. The much smaller xenon arclamp will utilize only about

$f/3.5$ of the lens aperture. If a fairly long condenser lens train is used it may still be necessary to use the conventional $f/1.6$ or $f/1.5$ lens in order to pick up all the light that comes through the aperture, but this does not mean that the lens is working at full efficiency. A compact condensing lens system with a projection lens of $f/3.5$ aperture will deliver just as much light to the screen, and will give excellent uniformity of screen illumination.

The important implication of what I have just stated is that a properly designed projector for use with the xenon lamp could use an $f/3.5$ projection lens, which, for the same cost, could be very much better corrected than those now supplied in the $f/1.6$ speed. The great brightness per unit area of the xenon arc makes up for its inability to fill a large-aperture projection lens, so that even with the lens of moderate aperture we may still expect to obtain the amount of light needed for theater-size screens.

An important further consequence of the small size of the xenon light source is that the anamorphic lenses required for projection of wide-screen pictures will be easier to design and will be smaller, lighter, and better corrected.

A considerable amount of work remains to be done to determine the best way of using the xenon lamp. In the demonstration given in 1954 the lamp was pulsed at 120 cycles/sec, taking advantage of the fact that 24 is $\frac{1}{5}$ of 120. The dark periods between light pulses were considerably longer than the flashes, and were long enough that the film could be advanced during every fifth dark period, since the JAN-Spec machine has a very fast pulldown. This machine therefore had no shutter.

Others who have been working on the development of xenon lamps feel that it may be better to operate the lamp continuously on rectified direct current and use the conventional shutter. Until both systems have been worked out completely it is difficult to predict which will lead to the smaller and simpler power-supply system. The lamps cannot be operated directly from either a-c or d-c supply lines, since they require large currents (30 to 100 amp) at low voltages (16 to 30 v, in different designs). Furthermore, they require high-frequency, high-voltage pulses to start the flow of current. One of the most ingenious features of the system demonstrated in 1954 was the circuit arrangement by which these high-frequency pulses were supplied at 120/sec in synchronism with the action of the projector mechanism.

**Mechanical Design**

As I said before, in the rational design of a projector all this work on the light source and optical system should precede any mechanical design. Once the optical system has been worked out in its best form, the mechanical designer's task is to put the necessary supporting structure and mechanism around it without requiring that it be changed in any way. This, I believe, has never been done in the development of the existing commercial projectors. Most of these machines, unfortunately, contain mechanical features which make it impossible to use highly efficient condensing lens systems. The JAN-Spec projector is better than any of the others in this respect, and this is why it succeeds in delivering approximately twice as much light to the screen as any other portable 16mm projector.

Among the characteristics to be desired in a portable projector, quiet operation would surely be near the top in any list. I believe that a great deal can be accomplished in the direction of a quiet mechanism by two steps:

(1) Design the gear system so that, apart from the motor and the intermittent movement, there is only one fast running shaft, this being the main driveshaft.

(2) Employ a type of intermittent movement which cycles only once per picture frame instead of three times as is done in most present constructions.

The most important source of noise in most present machines is the claw mechanism which reciprocates at 72/sec, pulling down a frame of film on every third stroke (sometimes on every second stroke). This has been done in order to get a very quick pulldown and to equalize the load on the driving mechanism.

The most desirable form of pulldown is the intermittent sprocket, as is well known. There are difficulties in applying it in a 16mm projector because the conventional four-sided star type of Geneva mechanism cannot be used, and a Geneva with a six- or eight-sided star, which would give a sprocket large enough to be practical, does not give a quick enough pulldown.

There are several ways of getting around this difficulty. In the one machine now on the market which uses a Geneva and an eight-tooth intermittent sprocket, the action is accelerated by a two-stage eccentric pin-and-slot drive. This is effective, but too large for a portable machine. A more elegant solution uses a pair of elliptical gears to transmit motion from the main drive to the cam shaft. This construction can be quite compact, and can be enclosed and run in oil or grease. A few years ago it would have been impractical because of the difficulty of generating the elliptical gears, but modern developments in gear shaping have made this fairly easy. There are still other ways of solving the problem, some of which may be described at some later time.

If an intermittent sprocket type of pulldown is used it should be provided with a flywheel to smooth the operation. This, of course, has been done in 35mm projectors for many years.

Speed reductions in the projector mechanism should be accomplished by means of worms and worm gears; these are completely silent in operation.

Actually all the necessary functions in a projector can be performed by a system of eight gears if we do not count the elliptical gears that may be built into the intermittent movement.

A quiet-running projector will not need to be operated in a case. This will be a great gain in convenience for those who operate it.

The sound reproducing system of a high-quality, portable projector offers few problems. The Davis type of drive or one of its modifications will give excellent freedom from flutter provided the design is worked out to permit using a flywheel having about four times the moment of inertia of those now used. The resulting motion should have no more than 0.1% flutter when reproducing photographic soundtracks, and should be better than 0.2% when pulling magnetically striped film past a reproducing head. The standard of 0.25% flutter for photographic sound track reproduction which was incorporated in the JAN-Spec seems to me to be not good enough. It is fairly easy today to record and print photographic soundtracks so that the flutter content is not more than 0.05%.

The optical system which focuses the scanning light beam should be designed to produce a line of light 0.0003 in. in height. If this is focused half-way between the two possible emulsion positions of the film, the effective scanning beam width will be 0.0005 in., which permits reproducing efficiently the range up to 8000 cycles. The optical system can be of the familiar type made up of three cylindrical lenses. One large projector manufacturer is already close to the practice I am recommending here.

A mechanically quiet projector will introduce little background noise into the sound system by vibration of the photocell; nevertheless, if we are to keep the system noise 55 to 60 db below the level of an average signal, as we must to take advantage of the extremely quiet soundtracks which we now know how to produce, it will probably be desirable to use the lead sulfide type of cell. Most of the valid objections to the use of these cells have been overcome by the recent methods of producing color prints with silver soundtracks, which are efficient absorbers of the infrared wavelengths to which the lead sulfide cells respond.

The design of audio amplifiers has undergone extensive development in recent years as a result of increasing general interest in "high fidelity" reproduction of music. Some of these fairly new circuits which give high power output

with extremely low distortion could well be used for sound film reproduction.

Probably the most serious obstacle to the production of high-quality sound by a portable system is the difficulty of obtaining a loudspeaker of wide frequency range without excessive size and weight. This limitation may always exist for a completely portable system. It is a limitation primarily at the low-frequency end of the response. Nothing prevents our reproducing a wider range of high frequencies than we are doing at present, and these contribute greatly to naturalness and intelligibility of speech. Perhaps it is fair to say that the low-frequency limitation is not too serious, since we are primarily interested in *talking* motion pictures.

**Conclusion**

You will have noticed that my discussion has been predicated upon an entirely new design for a projector. I believe that this is necessary if we are to obtain the full quality of performance of which 16mm films are capable. I am convinced that such a projector, once in existence, would be of great value to the Armed Services and to all who are interested in the many educational applications of the motion picture. I have presented these thoughts in the hope that they may help someone at some time in the not too distant future to create a machine capable of this higher standard of performance.

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# Letter to the Editor

## From a Pioneer — About the History of Sound Motion Pictures

[Editor's Note: Samuel Wein holds more than 100 patents for inventions in electronics, plastics, photography and chemistry. As he relates in his letter, he was a pioneer in television and sound-on-film. He experimented with selenium light-sensitive cells as early as 1914. Early in his career he did research work for Thomas A. Edison, and worked with other well known scientists, such as Charles P. Steinmetz, Elias E. Ries, and Allen B. Du Mont (of the Jenkins Television Corp.). He has published widely. Two of his books are *Metallizing Non-Conductors* and *Metallic Coatings on Non-Metallic Materials*. Besides the two early articles cited below, there is also an article about Mr. Wein's early work by John B. Brennan, Jr., "Light Sensitive Cells Make Talking Pictures Possible," in *Radio News*, 11: 723.]

Mr. Edward W. Kellogg (whose "History of Sound Motion Pictures" appeared in the June, July and August 1955 *Journals*) has suggested that I write you about my early efforts in recording sound photographically and reproducing it by means of light-sensitive cells. Two papers of mine, "Talking Motion Pictures and Selenium" and the "Gripenberg Selenium Cell," appeared in the *Electrical Experimenter*, June 1915. The first paper was the very first disclosure showing the use of a light-sensitive cell with an amplifier circuit. In this case I made use of a variable-density soundtrack. The disclosure showed the use of the manometric capsule as the variable light source, although in 1915 I patented the use of a gas-filled tube (neon, helium, etc.), the patent was "abandoned" for lack of interest by the industry at that time. The variations in light were amplified by a resistance-coupled or alternatively by a transformer-coupled amplifier.

The results were crude, but this was the germ of an idea that has steadily grown to its present development. The light-sensitive cell that I used at that time was the now extinct selenium cell. The expression "frequency response" (speed) of the cell to light was unknown at that time (1915). In 1916 I used the vacuum and the gas-filled potassium hydride photo-cell and thereafter I used the (1930) Becquerel type of light-sensitive cell (liquid-type).

You may also be interested to learn that my inventions were cited in certain early patent litigations (Tri-Ergon). I was not one of the litigants, but served as an expert. I demonstrated sound on film as early as 1913–1914 without pictures, using the Ruhmer film actually made as early as 1905. The Simon arc was the source of modulated light.

I think the above may be of interest to you.

June 9, 1956

Samuel Wein,
P.O. Box 65, Quincy, Mass

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# Erratum

Michael Rettinger, "Replaceable pole tip caps for CinemaScope magnetic reproduce heads," *Jour. SMPTE, 65:* 652–655, Dec. 1956

The engravings for Figs. 2A, 2B and 2C were interchanged. The drawing for Fig. 2A is in the Fig. 2B position; that for Fig. 2B is over the Fig. 2C wording; and the illustration for Fig. 2C is in Fig. 2A position.

# Recent Developments in Multichannel Stereophonic Recording Systems

By E. W. TEMPLIN

**The development of new facilities for large-scale motion-picture presentation has stimulated a commensurate advance in the realism of the reproduced sound. This paper discusses advances in equipment performance and operating technique applicable to the 6- and 7-channel stereophonic systems associated with these presentations, and describes the recording and re-recording facilities developed in several of the major Hollywood studios.**

In the last two years, significant advances have been made in the development of techniques and facilities for motion-picture theater presentations. The changes were primarily developed around a striking increase in the size of the screen. This offered opportunities for the deployment of action hitherto unavailable and presented a new perspective in entertainment to the viewing public. The larger viewing angle makes the viewer less conscious of the borders of the picture and gives him a new feeling of participation in the action involved. A further recognized value from the expanded picture, so far not fully exploited, is the logical one of permitting action to occur simultaneously over a larger scenic area. This not only provides much greater detail, but also reduces the need for a cut from a long shot to a close shot or from one close shot to another with the accompanying transitional interruption and departure from reality for the viewer.

Since the new large-scale projected picture has been based on meeting the requirements of a deluxe showing, expense has not been spared to retain or even improve the definition over that of the older, smaller picture. This has been done by such expedients as larger negative and print frame sizes, and new, complex photographic and projecion lenses. In at least one instance, the number of projected frames per second has been increased by 25% to minimize stroboscopic effects which would otherwise become more noticeable with the larger screen size and greater rate of movement on the screen.

With these efforts and achievements in the direction of dramatically improved pictorial presentation, it is only natural that a corresponding effort should be placed on the improvement of the accompanying sound in order that all reasonable steps may be taken to enhance its dramatic effect, and more specifically in order that any new capabilities of the picture be fully supported by the associated sound facilities.

A primary and very obvious requirement for a sound system associated with a new large-screen picture is that the characteristics of the sound be fully as realistic and dramatic as those of the picture. With the large screen, different portions of the picture appear at noticeably different viewing angles to the observer and the apparent position of the sound source must conform to that of the person or object producing the sound. Music and other effects which pictorially are spread over a considerable area in the picture should have their associated sounds similarly distributed. Movements of sound must be uniformly smooth and realistic.

On the basis of a large number of carefully controlled tests, at least three of the major studios have independently arrived at the conclusion that more than three separate channels of sound are required to meet standards of performance for the 50- to 65-ft screens being used in these deluxe systems. Accordingly, five separate channels have been provided to operate into five horn systems behind the screen. One or more additional channels have been added to provide auditorium effects, and in some cases to position effects in different portions of the auditorium.

Coincident with the effort and expense in providing a new degree of sound perspective, the engineers have rightfully taken a fresh look at the various performance characteristics associated with the sound in order that any new conditions or effects imposed by the introduction of additional channels would be adequately considered and fully exploited, and in order that recent advances in the art could be utilized to improve the basic sound quality and thus enhance the overall presentation.

In analyzing the various factors affecting sound quality, it was evident that many were interdependent. The extension of certain parameters made even more necessary the improvement of others. In some instances the introduction of certain advances made other advances more difficult.

The use of the newest high-quality magnetic emulsions and improved manufacturing control of the magnetic heads made it possible to obtain on film a uniform response over an extended frequency range from 40 to 12000 cycles, compared with the former photographic bandwidth of approximately 50 cycles to between 6000 and 8000 cycles.

The bandwidth in the new systems can be held to less than a ±1-db total amplitude variation over the extended range so that several generations can be produced with negligible degradation or change in sound quality. However, this extension in bandwidth provides a wider spectrum in which both background noise and distortion components may enter the system. Consequently, new efforts are required to maintain high signal-to-noise ratio and low overall distortion. The increase in the number of channels also has a direct bearing on the overall effective noise emanating from the complete system. Six channels produce six times the noise power of one channel, which corresponds to an effective increase of about 8 db in the noise level in the auditorium.

New limitations on allowable variations in system gain and recording level have been set to avoid unbalance among channels which would degrade the stereophonic effect. Because of these new, more stringent requirements for performance on almost all fronts, it was decided to develop new equipment wherever possible. This development included the production equipment used for original dialogue, music and effects, the elaborate re-recording facilities which provide the means for combining, modifying and correcting original tracks to produce the master release print, and the electrical transferring facilities for producing the release prints from the re-recorded master.

Two new basic amplifiers were developed for use with this new equipment.

Presented on October 10, 1956, at the Society's Convention at Los Angeles by E. W. Templin, Westrex Corp., 6601 Romaine St., Hollywood 38.
(This paper was first received September 4, 1956, and in revised briefer form on November 22, 1956.)

The RA-1556 type, which is the reproducing amplifier used throughout the recording and reproducing machines, contains the magnetic 6-db/octave characteristic and the low- and high-frequency post-equalization. The other amplifier, the RA-1554 type, is used for a general purpose line and recording output amplifier throughout the entire transmission system associated with the re-recording console.

In both of these new amplifiers, particular care was taken in the development to maintain very low distortion over the entire useful frequency range. In addition to the maintenance of a uniform performance characteristic for these amplifiers, trimming adjustments are available in some models to provide for very minor variations in frequency response and gain.

Figure 1 shows the distortion vs. frequency characteristic of these amplifiers. The lower line shows the distortion at or slightly above the normal operating level based on 3% distortion on the film itself and it will be observed here that in all cases the amplifier distortion is below ½%, and therefore completely negligible even under multiple-generation recording conditions. The upper curve for each of these amplifiers shows the characteristic 10 db above the maximum operating level used for 3% magnetic distortion, and again this shows that the distortion does not break appreciably until the level is well above normal recording conditions. These distortion characteristics also include the residual distortion of the oscillator which was used for the test.

Both of these amplifiers (Fig. 2) are the plug-in type which permit ready removal for maintenance or inspection. The RA-1554 Amplifier has the added feature of the cathode circuit of the output stage being brought to the plug terminal so that by external strapping on the associated receptacle the amplifier may be operated at its maximum power output capacity of plus 28 dbm, or at reduced output capacity at a corresponding reduction in plate current drain. Thus, the operating conditions for each portion of the circuit may be adjusted for maximum efficiency without in any way changing the circuitry within the basic plug-in amplifier.

**Production Facilities**

For production facilities, it seemed likely that many of the effects would be recorded originally on three or possibly five or six channels; therefore, it was considered expedient to provide 6-channel production-mixer facilities by using two 3-channel mixers patterned after the type which was used for earlier 3- and 4-channel systems.[1] The mixers may then be used in pairs for 6-channel pickup and separately, and simultaneously for 1- or 3-channel applications (Fig. 3).

The linear-type motion of the mixer controls is provided in order that the relative positions of the mixers may be more readily ascertained by quick inspection, and also in order that several may be simultaneously and independently adjusted by one operator. These linear controls are patterned after a type which has been used in re-recording at M-G-M studios for a number of years. The linear motion of the control knob is translated by cord and pulley to a conventional rotating-type attenuator. A continuously wound ladder-type attenuator is used for this purpose because of the lower friction involved. The control knob in the upper righthand corner of the lower panel permits rearrangement of the microphone inputs into one, two, three or four separate recording channels.

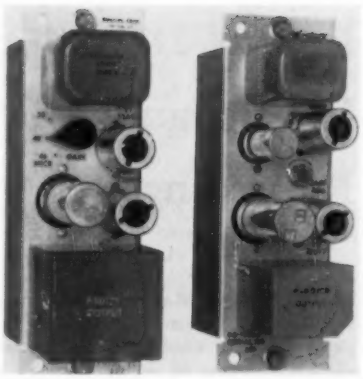

**Fig. 2. The RA-1554 and RA-1556 Amplifiers.**

When operated as a single-channel device, six mixer inputs are available. When operated as a multichannel system, the fifth and sixth mixer controls, which are plug-in elements, are removed to make space for an additional amplifier internally, and the remaining four mixers can operate in various arrangements into two, three or four separate recording channels.

The mixer uses the RA-1474 type, general purpose plug-in type amplifier which contains an additional internal plug-in facility for adjustable dialogue equalization in the case of the microphone preamplifier and adjustable mid-range equalization in the case of the recording amplifier applications. Two additional amplifiers of the same type provide left- and right-ear binaural headset monitoring for any of the various multichannel arrangements. Two mixers operate together to provide a maximum of six channels. These mixers were used in this manner for the Todd-AO production of *Oklahoma*, Twentieth Century-Fox's production *King and I*, and the experimental M-G-M demonstrations that were shown at the 80th SMPTE Convention.

The associated 6-channel production recorder is shown in Fig. 4. This is similar to the 3-channel recorder described in an earlier paper[1] with a few exceptions. A new record and reproduce head assembly has been provided with six uniformly spaced 100-mil tracks across the 35mm film. A base cabinet has been added to the recorder to provide a new bias oscillator with six

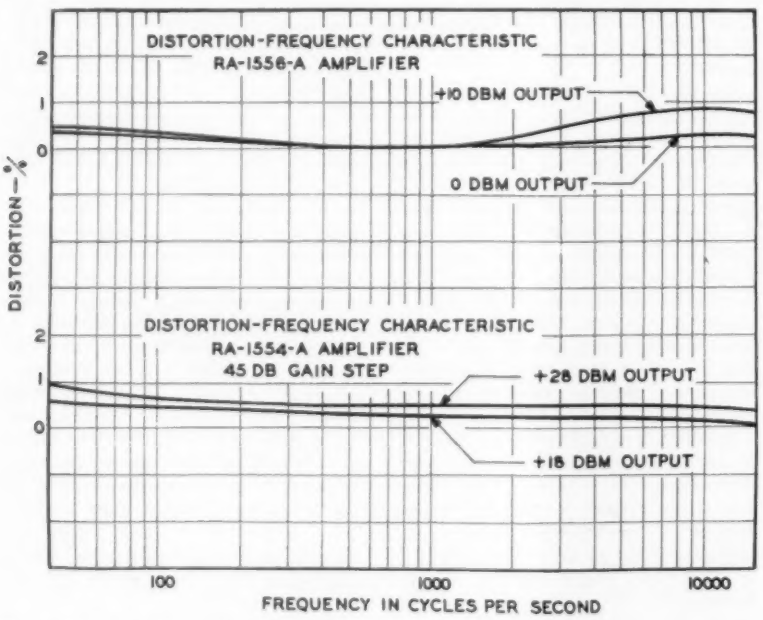


**Fig. 1. Distortion Characteristics of RA-1554 and RA-1556 Amplifiers.**

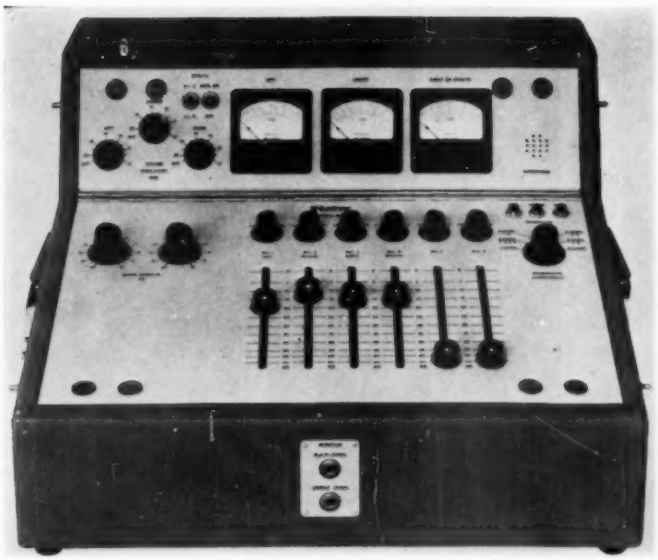

Fig. 3. The RA-1524 Mixer.

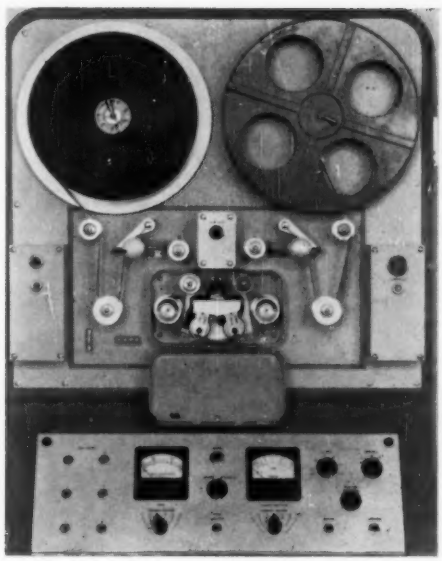

Fig. 4. The RA-1547 Recorder.

isolated and independently adjustable outputs, and facilities for monitoring the film output of all channels, separately or compositely.

**Re-recording Facilities**

The multichannel re-recording dummies and associated recorders and transfer machines are described in another paper.[2]

Bearing in mind that each of these machines has six soundtracks, corresponding to the six sound channels, it can be seen that the number of sound inputs to the re-recording console becomes very large for such a multichannel system. Actually in the case of the Todd-AO, M-G-M and Twentieth Century-Fox re-recording systems, there is a total of approximately 96 speech inputs to the re-recording console, corresponding to 16 6-track re-recording sources.

Mixer facilities are required for the simultaneously adjusting of all six tracks of each sound source, as well as for trimming or obtaining relative adjustment of each of the six tracks of each sound source. With the addition of mixer cutoff keys for each channel of each source, mixer group and master controls, plus the various auxiliary facilities such as single-channel and multichannel equalization, sound-effect filters and other miscellaneous items, the result is what may seem to be a very formidable number of controls. Consequently, considerable thought was given to simplifying the various controls as much as possible, ganging them where practicable to reduce the number of separate controls, and providing automatic switching means to transfer facilities from one portion of the circuits to another, or to cut them in or out of the circuit.

Proper arrangement and location of the controls make it possible for a crew of reasonable size to handle complex operations with a minimum of confusion and error, and the maximum flexibility for handling special situations which might arise.

Another important reason for expending initial planning effort in simplifying the controls was to permit the accomplishment of as many as possible of the procedures in a single recording, thus reducing the number of successive generations required.

Practically every facility has been made a plug-in unit in order that operating difficulties may be more rapidly isolated and corrected and routine maintenance procedures more easily accomplished. This method also makes the entire arrangement more flexible, permitting the insertion of special elements in the critical control area to meet particular special conditions without the complexity of basic equipment modification.

Figure 5 shows one of these 6-channel re-recording consoles as installed at Twentieth Century-Fox Studio. With some relatively minor but interesting variations, the same types of console and facilities have been used in the 6-channel re-recording consoles for Todd-AO and M-G-M. As can be seen from this figure, the console panel area is made up of a number of sections, each approximately 18 in. wide. In different custom-built systems the mixer, equalizer and panning-control groups can be rearranged in relative position to suit the requirements or preference of a particular studio.

An area is available in the rear of the consoles for the mounting of amplifiers and electronic equalizers. These also may be arranged in their relative positions along the console in accordance with each studio's requirements, so as to locate them adjacent to the controls with which they are directly associated

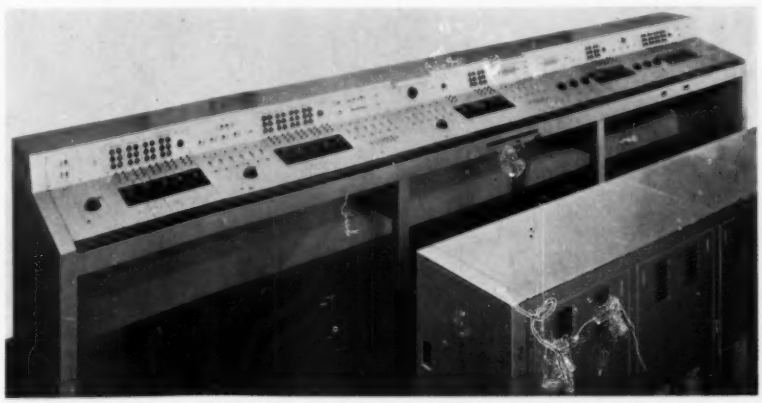

Fig. 5. The Twentieth Century-Fox Re-recording Console.

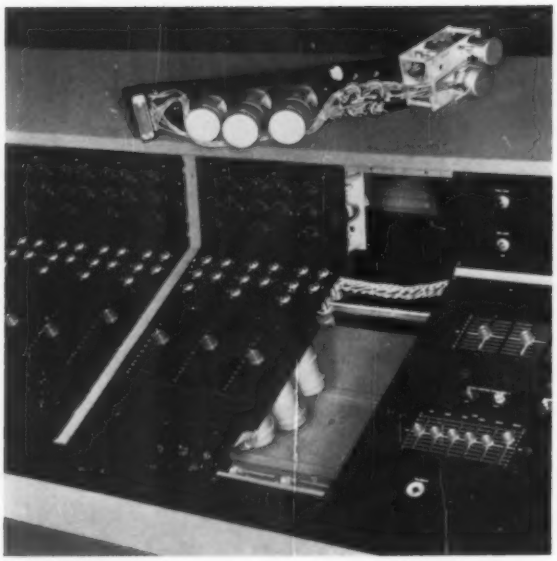

Fig. 6. The Re-recording Console Mixer Group.

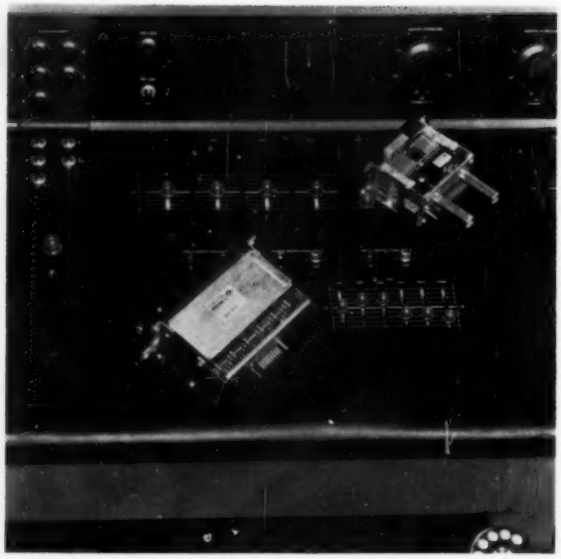

Fig. 7. The Re-recording Console Graphic Equalizer Control Group.

circuitwise. This feature allows a very significant simplification of the wiring of the console. Associated with each console and directly behind the mixer operators is an equipment cabinet containing: (1) additional facilities which are not required to be under the direct control of the mixer operators; and (2) patching panels as required for inserting special facilities or setting up special circuits.

A total of 16 6-channel program inputs come to the console. These incoming lines are divided into four groups of four mixers each, each with a master group control, if desired. One group is normally intended for dialogue, one for music, one for effects and a fourth for additional music or effects material. These four group outputs plus one auxiliary output can be operated in any desired combination into either or both of two recording machines. Thus, it is possible to make two identical recordings simultaneously, or to make two different masters, one of which, for example, may be a minus-dialogue track for foreign release.

Figure 6 is a close-up of one of these mixer groups with three of the plug-in mixers in position and the fourth and fifth removed. Each plug-in mixer handles the multi-channel output of one re-recorder, in this instance only five of the channels being brought to the ganged control assembly. The five mixer pots are ganged together and connected by cord and pulley to the linear drive. Individual cutoff keys are provided, these being used mainly for test and for track identification purposes. On the upper sloping portion are the separate trimming attenuators used for correcting the relative balance of the tracks for proper overall stereophonic effect. These trimmers have been found to be necessary because of irregularities and variations in acoustic pickup conditions which cannot be controlled adequately during the production. It should be remembered that this rather complex mixer assembly containing ten attenuators and five keys takes the place in the conventional single channel of a single attenuator.

The process of equalizing the various soundtracks also becomes more complex in the multichannel system and here it was found desirable to use the so-called graphic type of equalizer control as originally developed by Fred Wilson of Samuel Goldwyn Studios. In this type of equalizer, the frequency spectrum is divided into six bands, each covering an equal logarithmic interval, and the level in each of these bands may then be separately raised or lowered over a ± 8-db range by the linearly operating control. Thus, a great flexibility of adjustment is available.

In addition to providing controls each of which can be manipulated by one finger, this unit has another advantage in that the relative positions of the knobs show graphically the characteristic of equalization which is being applied and this characteristic can thus be interpreted at a glance.

In some cases, particularly on single-channel dialogue or effects, one graphic equalizer can take care of a complete track before panning it or distributing it to the various output tracks. However, where a 5- or 6-channel soundtrack is provided, it is usually necessary to

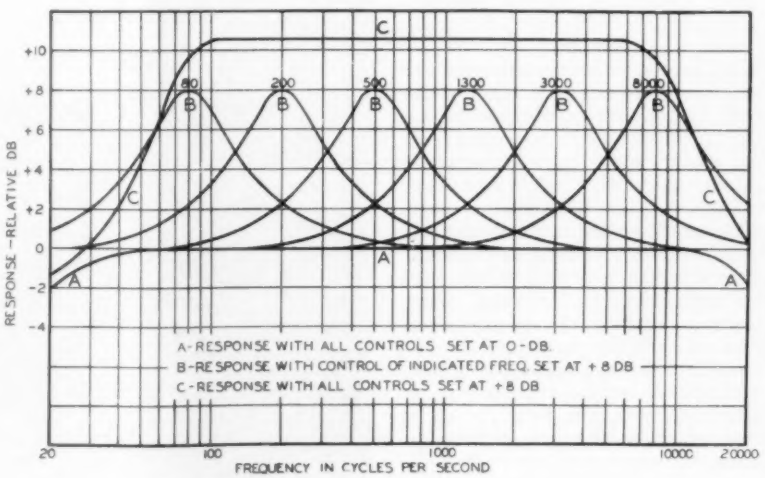


Fig. 8. Typical Frequency Characteristics of RA-1576-A Equalizer.

control the equalization of all channels simultaneously and equally, and therefore a ganged type of graphic control is required.

Figure 7 shows two of the single-channel 6-band graphic equalizer controls, one of which has been unplugged from its normal position. These particular ones were modified from a design by Cinema Engineering Company. Above these are the six controls of a 5-channel graphic control assembly we have developed. Each basic control, similar to the one shown removed, covers only one frequency band, and therefore a total of six of these units is required to take care of the complete spectrum for five channels.

An associated RA-1576-A Equalizer is operated by these controls. This is an improved type compared with those used earlier. Contact noise generated in the associated control has been virtually eliminated. The signal-to-noise and maximum undistorted output have been improved. Irregularities in the gain as the control potentiometer is adjusted have been minimized, and a relay has been added which can be operated remotely to enable or disable the equalization. This latter feature has been found to be very convenient in two specific respects:

(a) Equalization may be inserted or removed instantaneously during a take, such as in a cut between a telephone and a direct conversation.

(b) The equalization, in changing the relative gain at particular frequencies, can affect the relative level of test tones which are applied at the beginning of each take as a check of the gain in each channel. Temporary removal of the equalization just before the take is started permits proper application of the test tones, independent of special equalization settings.

Typical examples of equalization characteristics available with the graphic equalizer are shown in Fig. 8. This shows the characteristic obtained by adjusting each band separately to its maximum boost value, and also that obtained when all bands are simultaneously placed at maximum boost. The inverse response is obtained if the controls are moved to the maximum attenuate positions.

Pan-pot facilities are provided in the re-recording system for converting a single-channel input to a 5-channel output. In the M-G-M installation these controls are completely separate from the mixer and effects controls. As shown in Fig. 9 they are centrally located in the equipment cabinet. In the Todd-AO and Twentieth Century-Fox installations the pan-pot panels are located in two or more areas along the console.

In addition to positioning the sound at any point between extreme left and extreme right screen, the effective width of the sound source may also be adjusted from a single channel to full wide-screen distribution. In some cases there is the additional requirement of converting three-channel stereophonic tracks to 5-channel tracks. This may be accomplished by operating a 3-channel track, which has already received any necessary balancing or corrections, into a fixed 3- to 5-channel network. The three inputs connect directly to the far left, center and far right channels respectively, of this 5-channel system. The left-center track is made up of the left and center inputs only and the right-center track is made up of the center and right inputs only.

Another control facility provided is the relay switching of any equalization or effect facilities in or out of any circuit or from one circuit into another. Such changes can be effected in all channels simultaneously by operation of one remote pushbutton.

In general the controls have been arranged so that all functions, excluding the pan-pot controls, are symmetrically located in two groups, in the lefthand and righthand halves of the console. It is expected that in many of the dubbing operations one man can handle each half of the console. In sequences where the operations become more complex, each half can be operated in two parts with a total of four operators. It is felt that very seldom will more than four operators be required at the mixing and equalizing controls and two at the pan-pot controls.

While considering the general console designs, one just completed for Universal Studios (Fig. 10) is of interest. Although containing many of the same new circuit elements and systems features already described, it was designed for use on standard single- and 4-channel productions.

With the fewer number of channels, it was possible to add further operating flexibility without undue circuit complexity. The chief example is the use of pushbuttons at the mixer positions for accomplishing a wide variety of changes in circuitry.

The system accommodates four 3-channel and 20 single-channel inputs which may be used in various arrangements to produce one to four output channels.

The first four sections, from left to right, control music, dialogue, pan-pot and effects. One additional section on the far right is an auxiliary station which may be used for any additional music or effects tracks.

A close-up of one section is shown in Fig. 11. The pushbutton facilities permit instantaneous connection of any mixer output into any group control input or directly to any of the four channels. The group output may be connected

**Fig. 9. The Pan-Pot Control Group at M-G-M.**

Fig. 10. The Universal Picture Co., Inc., Console.

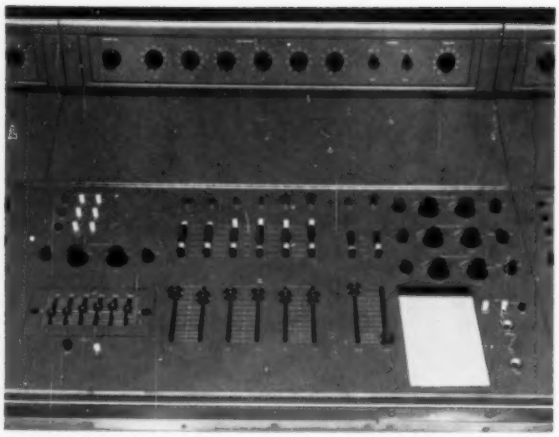

Fig. 11. Mixer Section of the Universal Picture Co. Console.

into any of the four channels or any number of group outputs may be combined into any one channel.

A 3-gang graphic equalizer may be "punched" into any of the four 3-channel mixer lines.

The availability of four channels also permits the recording of separate music, dialogue and effects master tracks.

A final word might be said concerning the overall performance obtained with these new systems. The overall re-recording and electrical printing systems are essentially 1 : 1 within a total range of approximately 1 db for each generation over the full frequency range from 40 to 12000 cycles. The signal-to-noise ratio on the original master-track prints is approximately 64 db on the basis of 6 db low-frequency and 4 db high-frequency recorded pre-equalization. The overall signal-to-noise on the composite print is between 56 and 60 db. The overall crosstalk ratio is better than 40 db. That the basic goal for these new sound systems has been achieved is demonstrated by the recent Todd-AO and Twentieth Century-Fox productions mentioned earlier in this paper. However, the credit for these very successful accomplishments must rightfully go to the studio personnel who have taken these facilities as tools and, by their painstaking techniques and imaginative artistry, have again met the challenge of providing a dramatic advance in motion-picture entertainment.

**References**

1. J. G. Frayne and E. W. Templin, "Stereophonic recording and reproducing equipment," *Jour. SMPTE, 61:* 395–407, Sept. 1953.
2. G. R. Crane, "Improved magnetic recording and re-recording facilities," *Jour. SMPTE, 66:* 59–63, Feb. 1957.

# Improved Magnetic Recording and Re-Recording Facilities

By G. R. CRANE

**Recent advances in studio use of multichannel magnetic recording and reproducing have required the development of specially designed film transport mechanisms. This paper describes a basic design with sufficient versatility to meet all the varied requirements imposed by film widths ranging from 16mm to 70mm and by a wide range of film speeds. A choice of magnetic heads and transmission facilities provides for single or multitrack operation with up to 7 channels. Versions for optical or magnetic operation and magnetic printing are also included.**

THE RECENT ADVANCES in the art of multichannel magnetic recording and re-recording in motion-picture studios have brought about demands for facilities that can no longer be adequately supplied by modifications or addition to equipments originally intended for monaural recording on standard 35mm film. Within the past few years, we have seen the demand for multichannel systems grow from 3-channel to 4-, 6- and 7-channel systems. At the same time we have witnessed the appearance of films varying in width from standard 35mm to 55, 65 and 70mm film.

The standard speed of 90 ft/min has been abandoned in several of the new systems with speeds running as high as 140 ft/min for Cinerama, with other intermediate speeds contemplated. At the same time, the increasing use of 16mm film for professional purposes has emphasized the necessity of providing the highest quality equipment for this gauge film. Modern program requirements have increased the recording time from the previous 1000-ft reel with approximately 11-min playing duration, to 30 min for many special applications.

In order to meet the demands of the industry and the new requirements imposed on equipment, the Westrex Corp. decided in 1953 to undertake the design of a new series of studio magnetic recorders and reproducers. The first application of this work was equipment for the 6-track, 5-channel stereophonic sound system associated with the Todd-AO process. Variations of these designs are now available for studio operations for single-, 3-, 4-, 6- and 7-track operation and with films of various widths. They are currently being supplied for the 6- or 7-track, 5-channel stereophonic system associated with the Twentieth Century-Fox 55mm CinemaScope and for the multichannel stereophonic system being currently developed by M-G-M. In addition, the new type of mechanism has been extended to optical and combined optical-magnetic reproducers.

Presented on October 10, 1956, at the Society's Convention at Los Angeles by G. R. Crane, Westrex Corp., 6601 Romaine St., Hollywood 38.
(This paper was received on September 12, 1956.)

### Requirements

Before discussing the actual design considerations of the equipment, the principal requirements will be noted. Five different widths of film were encountered: 70, 55.625, 35, 17.5 and 16mm. While the last two film widths are primarily for single-track operation, they still had to be considered in the overall equipment design to avoid the need for special equipment. Four film speeds were required: 140 plus, 135, 90 and 36 ft/min. Three types of motor systems and five motor speeds were encountered. A series of magnetic recording and reproducing heads was required to accommodate 7 tracks, 6, 4, 3 and a single track. The width of tracks and the location of tracks were also variables. The usual studio requirements such as good film motion with negligible flutter, convenience of operation and simplicity of maintenance, are well known and call for no comment other than to state that these details have been given careful consideration.

The requirements of the various studios for the associated transmission equipment are alike to the extent that all tracks must be in close agreement with respect to both level and frequency response. They differ materially, however, as to the types of equalization desired and to a lesser extent as to the range of frequency over which a flat response must be maintained. Crosstalk between adjacent channels or tracks must be held to limits consistent with the particular application, and minimum signal-to-noise ratio of 55 db is considered essential.

It has been found possible to install the transmission equipment for the various studio reproducers in the reproducer cabinet. In the case of the multichannel studio recorders, it has been necessary to install most of the recording transmission equipment in a cabinet similar in dimensions to that of the recorder, the two cabinets being located side by side.

### Film Mechanism

It has been found practical to provide a single film drive mechanism which will meet all of the foregoing requirements. The principal adaptations involved to meet special requirements consist of variations in the width of film sprockets and rollers to accommodate the various widths of film, and variations in a pair of drive gears to accommodate various film speeds and the use of different, interchangeable magnetic-head assemblies to accommodate the various numbers of tracks and track positions on film. Any one of several motor drives is applicable to any type machine.

Figure 1 is a front view of the basic 35mm reproducer which is typical of all types of this machine. The equipment is flush-mounted in a cabinet with hinged trim strips for easy removal of any panel section. The film-drive mechanism, with the exception of the motor and the rewind and takeup assemblies, is mounted on one vertical panel section. The feed and takeup-reel spindles are mounted on similar panels above and below the one containing the drive mechanism. The flush-type mounting permits the use of film reels up to $17\frac{1}{2}$ in. in diameter which accommodate 3000 ft of film.

Figure 2 shows a close-up view of the panel containing the film-drive mechanism for 16mm film. The film path is of the Davis Drive[1] type to provide good film motion at the heads, with a total flutter content due to film motion of less than 0.1%. Considerable thought has been given to the ease of threading and simplicity of operation. The number of moving parts has been reduced to the minimum required to be consistent with these objectives. The filtered section of the film path includes a single large film sprocket, two filter rollers which provide damped compliance, and two impedance drums. This arrangement provides a high degree of attenuation of disturbances originating in the feed or takeup film paths, motor system or driving mechanism components. In addition, two damped shock rollers are used to absorb any shocks which might be introduced by feed and takeup reels and the effects of the high inertia of large film reels. A film-driven

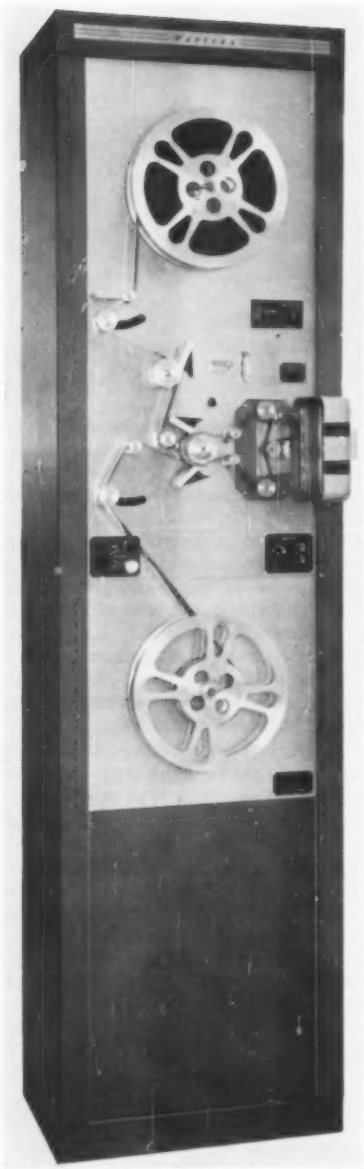

**Fig. 1. RA-1551-B Reproducer for single-channel magnetic reproduction on 35mm film; shield box open.**

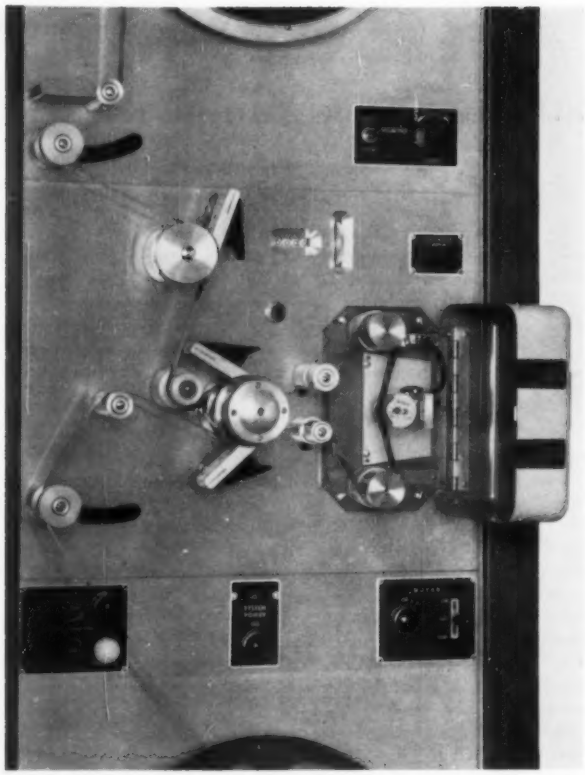

**Fig. 2. Close-up of RA-1551-G Reproducer for 16mm magnetic reproduction.**

footage counter indicates the footage in the forward direction of film travel and subtracts for reference in rewinding.

The film sprocket is driven by the motor operating through a timing belt drive and a single pair of right-angle helical gears. A large knurled knob on the film sprocket, when depressed against spring pressure, disconnects the sprocket from the motor drive. This permits the adjustment of the film to a desired start mark without disturbing threading or the interlock motor position. Means are provided for rapidly threading the correct length of film loop between the film engagements with the sprocket. When the lower sprocket pad is open, the two filter rollers are locked in a position equivalent to their normal operating relative spacing. The film loop may then be threaded readily without slack, and the correct length of loop is verified by a film-threading signal lamp which will light if an incorrect loop length of plus or minus one sprocket hole exists. If this lamp lights during operation, it is a warning that the correct length of loop has been lost due to damaged film and that an excessive flutter condition may possibly exist depending upon the amount of loop lost. A control knob is provided for adjusting the mean position of the filter rollers while the machine is in operation.

A variable, high-speed rewind with automatic shutoff is provided by a series-wound motor which drives the feed spindle through a rim-drive arrangement. Contact at the rim-drive is made only during actual rewind operation. The feed spindle is provided with a light payout drag for normal operation which is removed during rewind.

The basic reproducer is equipped with a single-track magnetic head mounted on a standardized base plate. This head subassembly has adjusting facilities for obtaining azimuth, track position and proper contact with the film. It is mounted in a shield-box for adequate shielding of all types of single or multiple heads.

### Motor Systems

A number of different types of motor operation are available to meet the various studio requirements and the equipment is wired to accept any one of these.

Interlock operation from the distributor bus is provided by the usual interlock motor operating at 1200 or 1000 rpm. Either 4-pole or 6-pole synchronous motors may be used on a three-phase line supply, or single-phase if desired.

Composite motor operation is obtained with the use of a composite motor. This type of motor operation is relatively new and deserves mention. The motor consists of a 4-pole interlock motor and a 6-pole, 230-v, 3-phase synchronous motor in the same frame. The interlock section can be connected to an interlock distributor bus just as a standard interlock motor and the synchronous section of the motor can be connected to a 230-v, 3-phase line.

The motor may be also operated in interlock from start with a number of

(This paper was received on September 12, 1956.)



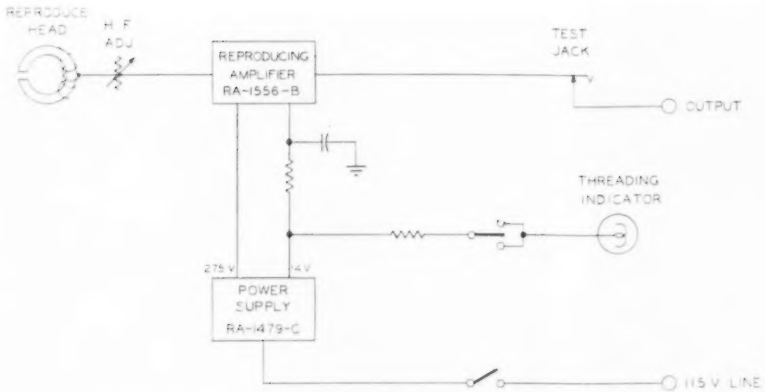


**Fig. 3. Simplified block schematic of the basic, 35mm, single-tract magnetic reproducer.**

similar motors without the use of a distributor. A 9-conductor bus is provided to which all such motors are connected. The motor system operation is controlled by a switch which has an "Off," an "Interlock" and a "Run" position. The switch is operated first to "Interlock." Through power relays one phase of the power line is connected to the interlock stators which puts all the motors in interlock since their rotors are connected together. The switch is then operated to the "Run" position, which connects the other two phases of the power line to the interlock stators and the motors accelerate as 4-pole induction motors and come up in interlock to 6-pole synchronous speed in about 3 sec, controlled by the value of resistance which is connected across the rotors. A time-delay relay transfers the 3-phase line from the interlock stators to the synchronous stators. The motors then continue to run in phase as synchronous motors. The motor system is stopped in the reverse order without loss of interlock.

### Transmission Circuit

The simplified block schematic circuit for the basic reproducer is shown in Fig. 3. The reproducer amplifier is of the plug-in type and has sufficient gain to provide an output level of zero dbm from fully modulated 200-mil track. A variable-gain control with a range of 6 db is mounted on the amplifier chassis and the amplifier output is normally connected for 600 ohms impedance. Three types of low-frequency post-equalization are provided by means of strapping as follows:

(a) Post-equalization complementary to the Research Council 6-db low-end pre-equalization.

(b) Post-equalization complementary to the Westrex 2.5-db low-end pre-equalization.

(c) No low-end post-equalization.

The reproduced high-frequency response from film recorded with the Research Council recording pre-equalization characteristic is essentially flat. Control of high-frequency response is available by adjusting a variable shunting resistor connected across the head and located on the magnetic-head subassembly. The output circuit is normalled through a jack located on the front of the cabinet. This jack is intended for headset or meter test purposes. The power supply is optional in this reproducer since the one power supply is capable of operating up to six of this type of reproducer. The noise level at the output terminals, with the magnetic head connected and with maximum amplifier gain, is −68 dbm or less.

### Reproducer Applications

One version of the reproducer operates with 16mm film. It is essentially identical with the equipment just described, with two exceptions. The film speed, the sprockets and rollers have been designed to accommodate 16mm film, and the reproducing transmission characteristic has been designed to conform with the ISO-SMPTE reproducing characteristic for 16mm film.

Multiple-channel reproducers differ principally in that additional transmission channels are employed and different types of magnetic-head assemblies are used to meet the particular application. In each case the magnetic heads and their associated variable resistors are mounted as an interchangeable head assembly, connected through miniature connectors, and pre-adjusted for azimuth, film contact and track position. In all current multiple-track magnetic heads the azimuth and alignment of the several head sections are nearly identical and there is, therefore, a negligible phase angle between the signals from any two head sections in so far as these factors affect the audio frequency range.

### Recorder Applications

Adaptations of the basic equipment to provide studio recording facilities become slightly more involved. Mechanically, the principal change is the addition of a second single or multiple head for the purpose of monitoring or playback. Again in this case, head assemblies are quickly interchangeable. Figure 4 shows a typical assembly consisting of two 3-track heads.

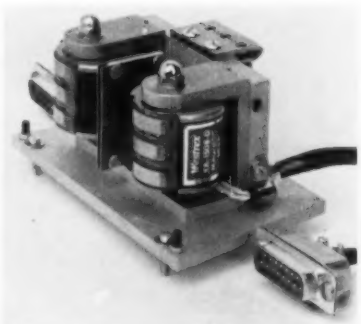

**Fig. 4. Three-track magnetic head assembly for recording and monitoring, which is typical of several types of interchangeable assemblies.**

Recording transmission components must be added. In the case of a single-channel recorder, these items are mounted in the recorder cabinet, but the transmission equipment for a multichannel recorder requires more space and is contained in a separate cabinet of the same size and general appearance as the recorder cabinet. The monitor amplifiers are located in the recorder since it is desirable that they be reasonably close to the magnetic heads.

Figure 5 shows the block schematic circuit of the transmission equipment used in the basic single-channel recorder. It is typical of the multiple channels used in the multitrack recorders except for certain special monitoring facilities supplied in the latter. The incoming signal goes through a recording attenuator and then through an equalizer which provides one of several types of low-frequency pre-equalization. The circuit then proceeds through the recording amplifier across the output of which a volume indicator is connected. The circuit then goes through an attenuator which is used only to compensate for relative sensitivity of recording heads so that with a fixed studio reference level at the volume indicator, 100% modulation of the film will be obtained in one or all channels. The circuit then proceeds through a network which provides the desired high-frequency recording characteristic, through a filter which isolates the high-frequency bias signal from the recording amplifier and volume indicator, and through a resistor across which the bias current is metered and to the recording head. The bias current is introduced just beyond the isolation filter. A 60-kc bias signal is supplied when recording at film speeds up to 90 ft/min, and 100-kc for higher film speeds.

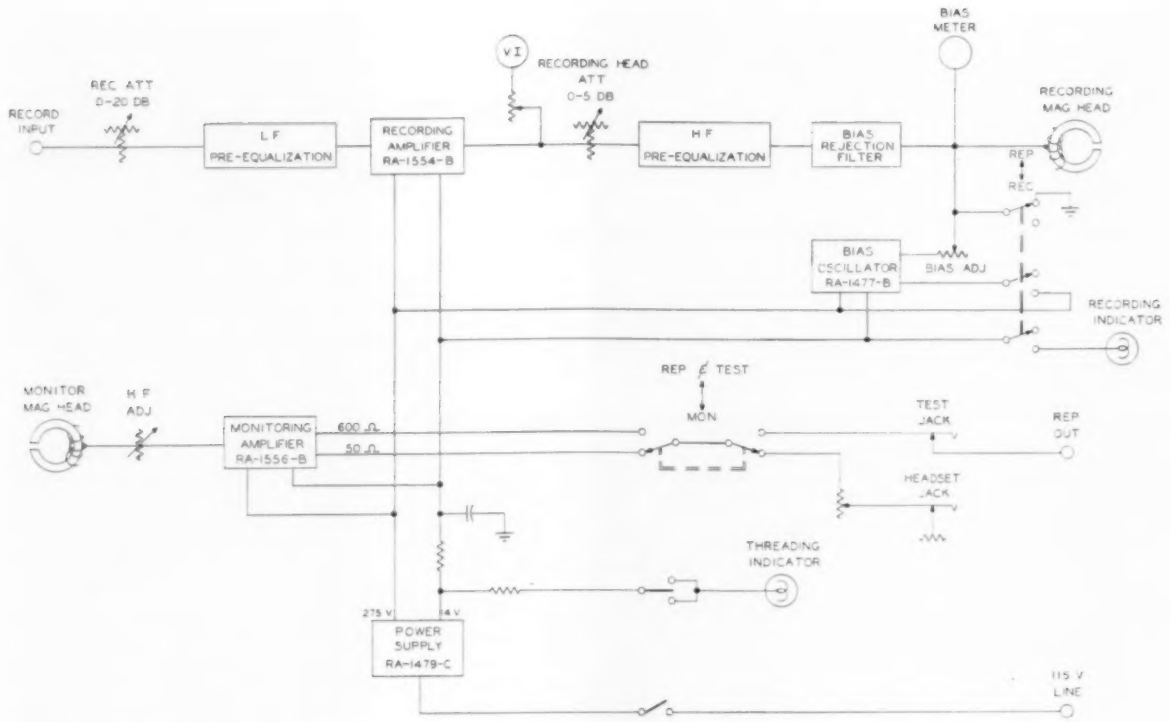


**Fig. 5. Simplified block schematic of the basic, 35mm, single-track recorders.**

For single-channel recording the monitoring circuit goes from the head through an amplifier which delivers a level of approximately zero dbm from fully modulated film. A selector switch provides either headset monitoring or a 600-ohm output circuit which may be connected to a power amplifier and loudspeaker.

In the multichannel recording equipment it is customary to supply switching facilities for monitoring any one of the channels individually or any desired combination of the channels collectively.

One version of this equipment for electrical printing provides means for simultaneously recording multiple tracks on striped composite release film. Figure 6 shows equipment of this type which was supplied to Twentieth Century-Fox Studios to record simultaneously 7 tracks on 55.625mm striped release film. The unit at the right is the 35mm, 7-track reproducer, the one at the left is the 55.625mm recorder with the transmission cabinet in the center. The reproducer operates at 90-ft/min film speed, but in this case the film speed of the recorder is 135 ft/min. These units are typical of the multichannel reproducers, recorders and equipment cabinets.

### Optical-Magnetic Reproducer

Another application of the reproducer is a unit equipped for both optical and magnetic tracks on 35mm film. It provides optical reproduction from either standard, single-track or push-pull, double-width photographic track or reproduction from 200-mil magnetic track. A close-up view of the film path is shown in Fig. 7. A single 16mm version is also available.

The film path varies from that previously described in that a scanning drum is located between the two impedance drums. For optical reproduction the film is threaded to the left of the scanning drum. This puts the soundtrack at the focal plane of the reproducing optical system and removes film contact with the magnetic head. For magnetic reproduction the film is threaded to the right of the scanning drum which brings it in proper contact with the magnetic head.

The optical system is essentially the same as one which has been previously described in the *Journal*.[2] It consists of a combination of front and rear scanning. The front-scanning section determines the height of the optical scanning beam of light and reduces the heat at the film plane to a negligible value. The rear-scanning section determines the effective width of scanning for either single- or double-width soundtrack. It also provides a readily observable, enlarged and modified image of the scanned area and simple facilities for selecting the type of scanning desired and for making any adjustments that may be required.

The reproducing amplifier contains appropriate circuits and equalization for optical and magnetic reproduction, with the usual controls associated with the selection of magnetic or optical, and the use of single or push-pull optical system.

It can provide for substantially flat response from magnetic film recorded with any one of the three characteristics previously mentioned.

An adjustable high-frequency equalizer is included to compensate for photographic film transfer losses.

An exciter lamp power supply and associated controls are also included.

### Conclusion

The listing of overall performance data is tedious in view of the many different applications and demands made on this type of equipment. For example, the signal-to-noise ratio is dependent upon track width, which varies from about 40 to 200 mils, but all multiple-track versions yield better than 55 db, and 3-track, 200 mil in excess of 60 db. Cross-talk is particularly dependent upon the proximity of the multiple tracks and type of multiple head used, but typical minimum values are 35 db for six 100-mil tracks spaced 60 mils apart, and 50 db for three 200-mil tracks spaced 150 mils apart. These values are found acceptable for stereophonic type

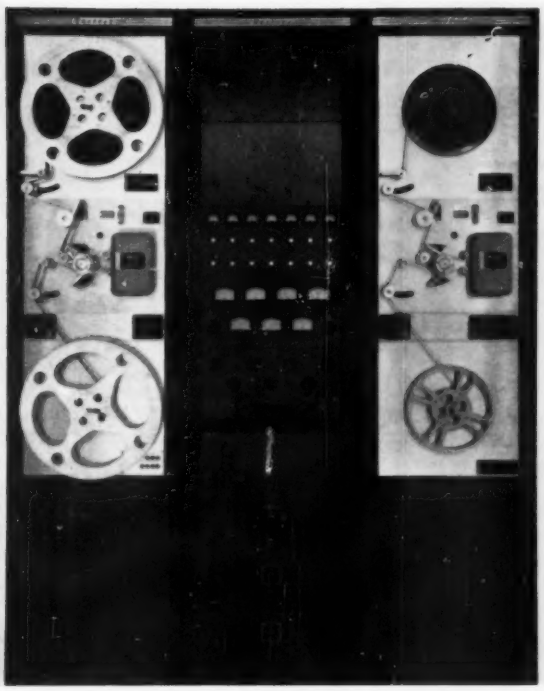

**Fig. 6. Special units for electrical printing of 55.625-mm release film. Recorder at left uses special heads for seven tracks on wide film. Reproducer at right receives signals from seven tracks on 35mm film. Transmission equipment in center.**

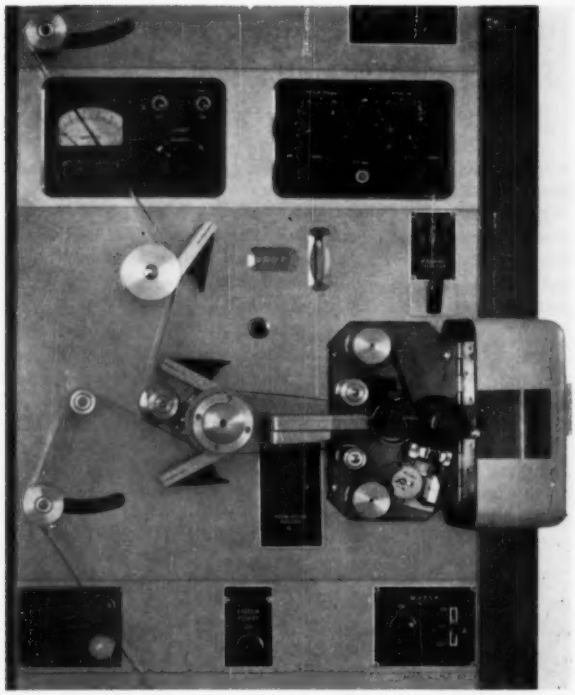

**Fig. 7. Close-up of RA-1570-A Optical-Magnetic Film Path, showing film threaded for magnetic reproduction. Threading to the left of the central drum gives optical reproduction with the film clear of the magnetic head.**

applications, but if 3-track recording for nonstereophonic requires less crosstalk, special heads giving values exceeding 60 db can be used as previously described in the *Journal*.[3]

It appears that this development has fulfilled all expectations with respect to its versatility, its dependability and simplicity of operation.

**Acknowledgment**

The author wishes to acknowledge the very substantial contributions to this work made by members of the Westrex engineering staff, in both the electrical and mechanical aspects.

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2. W. C. Miller and G. R. Crane, "Modern film re-recording equipment," *Jour. SMPE, 51:* 399–417, Oct. 1948.
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# Improved Technique for Ion-Exchange Recovery of Eastman Color Developers

By JOHN H. PRIESTHOFF

**A technique, recently described[1] for recovery of Eastman Color developers, has been modified. In the new method, developer is passed through the ion-exchange column only as long as sodium bromide is completely removed. The effluent solution is reconstituted to replenisher status by the addition of untreated overflow developer, developing agent and sodium sulfite. The advantages of this technique are: increased life of the resin, elimination of several chemical analyses and reduction in operating time by half.**

A METHOD for recovery of Eastman Color developers was recently described.[1] The overflow from the continuously replenished developer tank, instead of being discarded, was treated in an ion-exchange column. The treated developer was collected, analyzed and rejuvenated to replenisher formula by the addition of color developing agent and sodium sulfite. After these additions, it was desirable to reanalyze the solution.

In the method described,[1] effluent developer from the ion-exchange column was collected until the bromide concentration of the collected volume of effluent was equal to the concentration of bromide required in the replenisher solution. To attain this concentration, effluent developer containing a bromide concentration higher than that required by the replenisher, Area B, Fig. 1, must be collected in a quantity sufficient to make up for the quantity of effluent that initially comes through the column with a bromide content less than that required by the replenisher, Area A, Fig. 1. When Areas A and B are equal, no more developer would be percolated through the resin bed. For the Eastman Color Print developer being considered, the desired result was a replenisher containing 0.95 g/l of sodium bromide. As seen in Fig. 1, the last 15 l (approximately 33% of the total) flow through the ion-exchange column essentially unchanged. During this portion of the cycle the column is functioning merely as a pipe.

An improved technique has been worked out for the desired rejuvenation of Eastman Color developers. The resin, flow rate and regeneration solutions are the same as those previously described. The changes from the previous method are in the volume of developer throughput and the manner of reconstituting the effluent developer to replenisher formula status.

### New Procedure

The revised technique consists of passing the overflow from the developer tank through the resin column only for as long as the effluent contains no bromide. To this collected effluent is then added a quantity of untreated tank-overflow sufficient to raise the bromide concentration to that required for replenisher. Other constituents are added as needed. This method results in an increased life for the resin and in reduced need for special rejuvenation procedures, and eliminates the need for much of the chemical analysis required previously.

For Eastman Color Print developer it was experimentally determined that the first 15 l of developer per liter of resin passed through the resin bed free of bromide (Fig. 1). The bromide breakthrough occurred between 15 and 20 volumes of effluent per volume of resin. (For Eastman Color Negative developer the corresponding breakthrough is between 25 and 30 volumes.) In establishing the new technique, after each 15 volumes of effluent was collected, the flow was stopped and the resin bed was regenerated.[2] To show that the quantity of Kodak Color Developing Agent CD-2, sodium sulfite, and sodium bromide removed by the resin during each cycle remained constant, a control chart was kept of the analyses of the effluent of each cycle. During this experiment 90 batches of developer were passed through the resin before a significant loss in bromide capacity was observed. The analytical results of each cycle were tabulated, and it was found that approximately 95% of the time, $1.77 \pm .13$ g/l sodium bromide and $0.65 \pm .25$ g/l CD-2 were removed by the resin during each cycle. Sodium sulfite was removed only in small quantities, the average amount being 0.10 g/l; an amount greater than 0.20 g/l was removed less than 5% of the time. From the constancy of these results, it appears that it would be possible to eliminate the analysis of each effluent solution in future runs except for an occasional check analysis.

After 92 cycles, the resin bed was regenerated with sodium bicarbonate and sodium chloride,[3] but the resin did not respond to this treatment as had resin beds used in the previous method. Although further investigations might have solved this difficulty, the problem was not pursued further. If necessary, the resin could be discarded after 90 to 100 cycles and replaced with fresh resin. The cost of replacing the ion-exchange resin is insignificant compared to the volume of developer recovered.

### Calculations

A detailed discussion of a typical case will indicate the simplicity of the calculations that will be required.

For a 20-l resin bed, 300 l of developer can be recovered each cycle. To reconstitute this volume of effluent to replenisher formula, the following calculations are necessary. The values in Table I are known: those in column (a) from preliminary experimental runs; those in column (b) from daily analysis of the machine developer (the overflow has the same chemical composition as the tank); and the values in column (c) are those of a replenisher formula. These values are approximate and will vary from one processing laboratory to another.

**TABLE I. Average Concentrations.**

| | Developer Effluent g/l | Developer Overflow g/l | Replenisher Formula g/l |
|---|---|---|---|
| | (a) | (b) | (c) |
| Sodium bromide (NaBr) . . . . | 0.0 | 1.82 | 0.95 |
| Color Developing Agent (CD-2) . | .2.30 | 2.90 | 7.40 |
| Sodium sulfite ($Na_2SO_3$) . . . | .3.80 | 3.90 | 5.60 |

First a calculation is needed of the volume of tank overflow for addition to the 300 l of effluent to obtain a bromide concentration equal to that of the replenisher. This may be expressed mathematically by the following general equation:

$$(Lx) + (My) = (L + M)z \qquad (1)$$

Where $L$ = liters of effluent,
$x$ = concentration (g/l) of NaBr in effluent,
$M$ = liters of overflow developer needed,
$y$ = concentration (g/l) of NaBr in overflow, and
$z$ = concentration (g/l) of NaBr in replenisher.

Therefore:

$$(300 \times 0.0) + (M \times 1.82) = (300 + M)\,0.95,$$

$M = 330$ l.

When 330 l of tank overflow are added to 300 l of effluent developer, a total of 630 l of solution is obtained, which contains 0.95 g/l sodium bromide.

To find the concentration of CD-2 and sodium sulfite in the 630 l of combined

A contribution submitted on December 6, 1956, by John H. Priesthoff, Color Technology Div., Eastman Kodak Co., Rochester 4, N.Y.

developer, the following general equation is applied:

$$\frac{(La) + (Mb)}{(L + M)} = c$$

Where $L$ = liters of effluent,
$a$ = concentration of CD-2 (or $Na_2SO_3$) in effluent,
$M$ = liters of overflow added to $L$,
$b$ = concentration of CD-2 (or $Na_2SO_3$) in overflow,
$c$ = concentration of CD-2 (or $Na_2SO_3$) in $(L + M)$ combined,

For CD-2:

$$M = \frac{(300 \times 2.3) + (300 \times 2.9)}{630} = 2.61 \text{ g/l}$$

For $Na_2SO_3$:

$$M = \frac{(300 \times 3.8) + (330 \times 3.9)}{630} = 3.85 \text{ g/l}$$

From these calculations, the volume of developer overflow that should be added to the effluent and the resulting concentration of CD-2 and sodium sulfite in the combined developers have been determined. However, to reconstitute the combined developer solution to replenisher formula, additions of CD-2 and sodium sulfite are needed. In the example, 4.79 g/1 CD-2 and 1.75 g/1 sodium sulfite are required. There is a final adjustment of pH needed whenever this procedure is followed.

In making the above calculations for reconstituting the 300 l of effluent to replenisher formula, there has been no necessity for chemical analyses. The only values used in these calculations were those in Table I.

### Advantages of the New Technique

The equipment required for application of this technique for recovery of Eastman Color developers is the same as that used in the previously described method.[1] The main advantages of the new technique are:

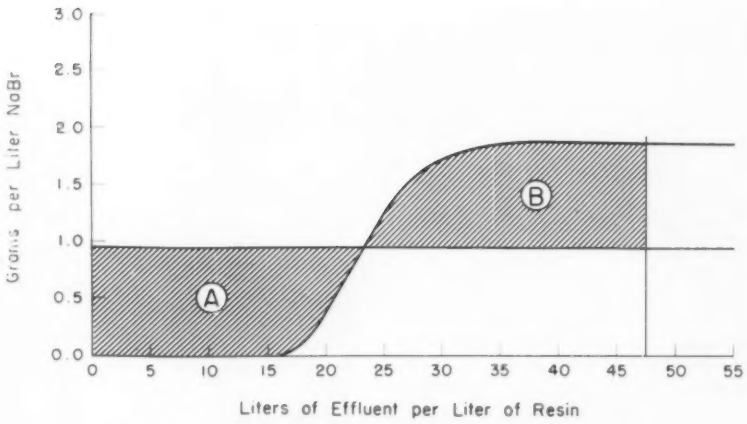


**Fig. 1. Curve showing sodium bromide breakthrough point for Eastman Color Print Developer.**

(1) The required number of analyses of solutions is very much reduced.

(2) Developer is run through the resin bed only for that portion of the cycle in which bromide is being removed. Since less developer passes through the column in each cycle, there is less contamination of resin with decomposition products and other impurities. The result is longer life of the resin and need for fewer regenerations with sodium bicarbonate and sodium chloride.

For example, in the previously described method,[1] approximately 47.5 liters of developer were recovered per liter of resin in each cycle. To reconstitute this effluent developer to replenisher formula would require almost the same quantities of color developing agent and sodium sulfite *per liter* as were required for the 630 liters treated using the new technique. The previous technique required about 8 hr for a complete cycle; the new, modified procedure requires less than 4 hr for a cycle. With the new technique the resin bed was used for 90 consecutive cycles with no regeneration other than the standard regeneration with 5% sodium sulfate solution followed by the 5% sulfuric acid solution. With the previous procedure seven rejuvenations with sodium bicarbonate and sodium chloride would be required during the running of 90 regeneration cycles.[2] This would mean that there would be 7 days in which the column could not be used.

This modified recovery procedure appears satisfactory for both Eastman Color Print and Eastman Color Negative developers. No cost comparisons have been made, but the chemical costs should be similar to those quoted in the previous paper.

### References

1. J. H. Priesthoff and J. G. Stott, "Ion-exchange recovery of Eastman Color Developers," *Jour. SMPTE, 65:* 478–484, Sept. 1956.
2. *Ibid.*, p. 480 (Regeneration Prodedure A).
3. *Ibid.*, p. 481 (Regeneration Procedure B).

# Burning Characteristics of Safety vs. Nitrate Film

A REPRINT

By ALLEN L. COBB

Since 1950 all motion-picture film produced by the major U.S. and Canadian manufacturers for professional and amateur use has had a "safety" base of cellulose acetate or other material which burns slowly. Formerly, most film was made with a film base of cellulose nitrate. There still seems to be some confusion over the differences between these two types of film. Where "safety" film is used or stored exclusively, no special fire protection precautions are necessary. While the change to acetate base film has been an accomplished fact domestically for about six years, some cellulose film is still in circulation and some nitrate film will be in storage for years for archival purposes. The NFPA Standards for the Storage and Handling of Cellulose Nitrate Motion Picture Film (NFPA No. 40) should be followed to safeguard life and property where this nitrate base film is being stored or handled.

This article illustrates the difference in the ignition and burning characteristics of the two types of film. It should be understood that cellulose nitrate contains chemically combined oxygen, sufficient in amount so that this material can partially burn or decompose without the presence of air. The gases formed by such decomposition are both toxic and flammable and may be produced so rapidly as to create a hazard to life and dangerous pressures in enclosed spaces. While the actual heat of combustion of nitrate film measured in British Thermal Units per pound is 6,000 to 8,000 compared with 8,000 to 9,000 for wood, the rate of combustion is about fifteen times that of wood in the same form.

Cellulose acetate film, in contrast, burns relatively slowly — about the same speed as paper — and the combustion products of burning safety film are much less toxic than the gases of cellulose nitrate.

### Loose-Film Burning Tests

At a series of tests, comparisons were made of the burning characteristics of nitrate and acetate films. Figure 1 shows the extent of a fire 15 sec after ignition of a pile of 1,000 ft of 35mm. nitrate motion-picture film which had been placed in a loose pile on the ground and ignited. The burning time was checked with a stopwatch at 38 sec. The nitrate film was completely consumed. Flames reached a

Fig. 1. Nitrate film 15 sec after ignition.

Fig. 2. Acetate film at height of fire.

Fig. 3. Simulated fire at projection on acetate film.

Fig. 4. Nitrate film during same simulated situation as in Fig. 3.

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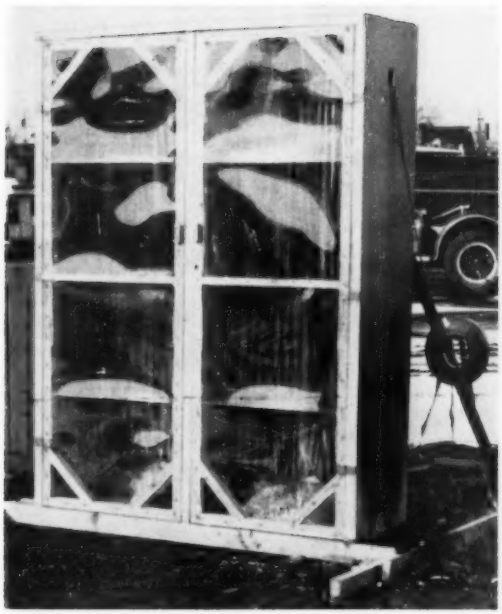


**Fig. 5. Acetate film in mock 35mm process machine dryer — burnout time 170 sec.**

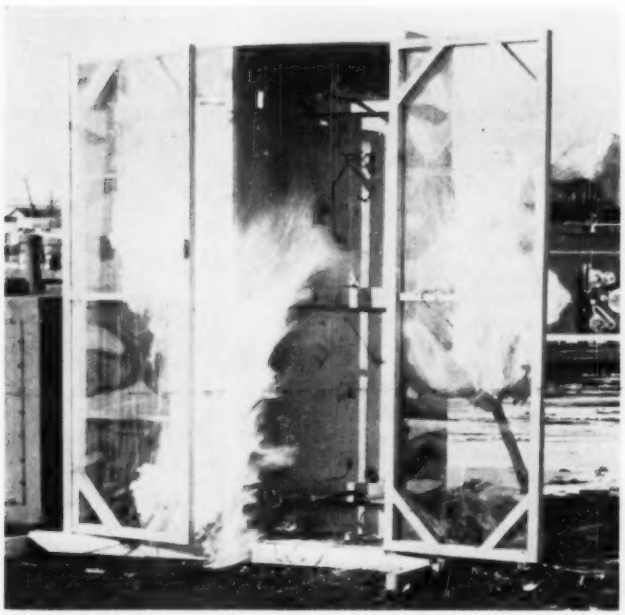


**Fig. 6. Nitrate film in same test as in Fig. 5— burnout time 55 sec.**

height of approximately 12 ft and gave off no visible fumes but did show some fly ash.

In a comparative test, 1,000 ft of 35mm. acetate motion-picture film was placed in a loose pile on the ground and ignited using a small wad of wood excelsior. Figure 2 shows the resulting fire at its height. The burning time was recorded at 218 sec. The safety film was not completely consumed and showed evidence around the edges of melting and curling. The flames of the safety film did not exceed two feet in height and gave off a black smoke.

About 1,000 ft of heavy craft paper, 35mm. wide, was placed in a loose pile under similar conditions. In this case, the burning time was checked as 124 sec. The flames were approximately two feet in height and considerable blue smoke and fly ash were observed.

About 1,000 ft of cotton fabric, 35mm. wide, was similarly ignited. Burning time was 155 sec; flames did not exceed two feet in height; very little fly ash was observed although there was some blue smoke.

### Simulated Projector Fires

Two Simplex projector magazines were mounted on a frame in such a way as to simulate the mounting distance which could be found on a theater projector. Acetate "safety" film, a full 1,000-ft roll, was placed in the top magazine with a strip of film leading down to the lower magazine which contained part of a roll of acetate film. The lower magazine door was left open and film was placed in a disorderly pile beneath as might be found in a theater following a film break. This small pile of film was ignited with a wad of excelsior and it was observed from Fig. 3 that while much of the safety film on the ground was consumed, the flames did not carry up the streamers from the bottom magazine.

Figure 4 is the same test repeated but this time nitrate film was used in both the top and bottom magazines with the film streamers in approximately the same location. The loose nitrate film on the ground was set on fire and immediately the film in the lower magazine ignited and burned with considerable intensity. The streamers from the top magazine

**Fig. 7. Extinguishing acetate film in test fire.**

**Fig. 8. Extinguishing nitrate film in same situation as in Fig. 7.**

burned to the opening in the bottom of the magazine, setting off the roll in the top magazine which burned completely and with considerable intensity. It was observed that the intensity of the flames in both top and bottom magazines was sufficient to melt the white metal holders for the film rolls and to warp and bend the magazines.

**Simulated Film Dryer Fires**

Using a mock 35mm process machine dryer section constructed of two-by-fours with Transite sides, top, bottom, and back with center partitions and doors made of acetate sheeting for visibility, acetate film was threaded throughout the machine to a windup roll on the outside. Film was looped from the windup roll down to the ground as could occur from a nonattended windup. This material was ignited with a wad of excelsior and the film on the ground burned without carrying up to the windup roll as shown in Fig. 5. The burnout time was 170 sec.

After the acetate was removed from the machine dryer section, the machine was threaded with 35mm nitrate film in the same manner as the previous test. The nitrate film was ignited and in 55 sec the entire quantity of nitrate film was consumed. The fire burned from the loose pile on the ground up to and ignited the windup roll following the film strip from the machine to the roll and igniting the material looped inside the first section of the machine. It burned rapidly inside carrying through to the second section which burned almost immediately, and after the pressure built up inside the machine, the doors blew open and the heat was sufficient to melt some of the acetate on the doors. Figure 6 shows the extent of the fire a few seconds after ignition. It was interesting to note that the acetate material on the doors did not ignite and burn.

**Extinguishment Tests**

Approximately 40 lb of acetate film was placed in a loose pile inside an enclosure approximately eight feet wide with an open face. The acetate film was ignited and the fire allowed to burn for about two minutes. A fire fighter using a dry chemical extinguisher, as shown in Fig. 7, readily extinguished the burning film

Figure 8 shows another test fire with 40 lb of nitrate film substituted for the acetate. Here the fireman used a water spray nozzle to attempt extinguishment. The flames did not appear to diminish in intensity despite the application of water fog and when the fire was finally extinguished practically all the nitrate film in the center of the pile had been consumed.

# Photographic Instrumentation at Project SMART

By DARRELL LASSITER and WILLIAM KRUPP

**Project SMART, Supersonic Military Air Research Track, is a 12,000-ft supersonic sled track designed and built for the Air Force. The track is located and operated to simulate pilot escape systems of high-speed aircraft. Photographic instrumentation of this site is described.**

PROJECT SMART, Supersonic Military Air Research Track, was conceived and constructed for the primary purpose of testing and evaluating the extremely important problem of our "jet-age," pilot escape from supersonic aircraft.

The project is located in Southwestern Utah 16 miles west of Zion National Park and 160 miles northeast of Las Vegas, Nev.

The track is situated atop Hurricane Mesa, a table-top plateau, which is 3½ mi long and rises 1,500 ft above the valley of the Virgin River (Fig. 1).

One of the prime requisites for the selection of a site suitable for the study of this problem was that "in flight" conditions of escape, from ejection to final parachute deployment, could be simulated. Other tracks could not completely meet this requisite because as soon as the test object returned to track level the "in flight" conditions ceased. Free fall from aircraft does not lend itself to a precise predetermined flight path and metric instrumentation is difficult.

Project SMART meets the requirements of simulated "in flight" conditions. Test vehicles (Fig. 2), simulating aircraft cockpits, are propelled at supersonic speed along the 12,000-ft continuously welded, precisely aligned track. Test objects are ejected near the end of the track and the 1500-ft drop to the valley floor allows sufficient free fall for parachute deployment.

**Instrumentation**

Photographic instrumentation must provide three types of data: (1) trajectory information to determine whether the pilot does or does not clear the empennage of his airplane; (2) attitude and gyrational effects resulting from wind loading or other forces to ascertain whether the pilot has exceeded the limits of human tolerances as set by Aero Med; and (3) to gather "what happened" — event coverage.

Trajectory data, which are plotted in terms of space coordinates and time, are obtained with the Bowen CZR-1 Acceleration Camera. Seven of these cameras are used with one camera designated as the "master" camera for the purpose of phasing the picture-taking sequence to the other cameras designated as "slave" units. The strobo-units in the slave cameras are triggered by the synchronizing pip generator in the master camera. Manual computing methods are used, therefore synchronizing the picture-taking sequence eliminates the need for interpolation in the data reduction process.

Timing is supplied to the cameras from a Hewlett-Packard low-frequency generator located in the fire control building. A temperature controlled quartz crystal which generates 100,000 c/sec within an accuracy of 0.001% is used as the standard. This frequency is divided to produce sine waves of 10,000, 1,000, 100 and 10 c/sec. The 1,000- and 100-c signals are amplified separately and passed through signal level meters and attenuators to separate lines running to the camera stations. The two signals are amplified at the camera stations and are shaped into square pulses of approximately 33-μsec duration for the 1,000-c and 100-μsec duration for the 100-c signal. These two signals are then mixed together and are used to excite a common neon bulb in the camera. An image of the electrode is projected on the continuously

Presented on October 10, 1956, at the Society's Convention at Los Angeles by Darrell Lassiter and William Krupp (who read the paper), Coleman Engineering Co., P. O. Box 6, Hurricane, Utah.

(This paper was received on September 5, 1956.)

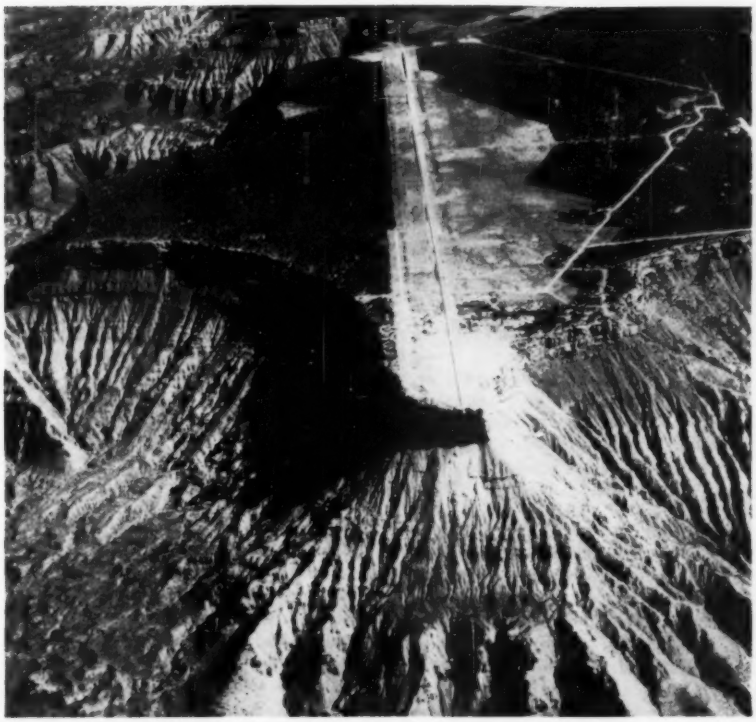


Fig. 1. Aerial view of Hurricane Mesa, showing the 12,000-ft sled track.

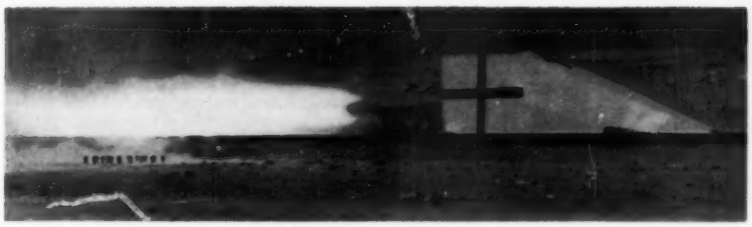


Fig. 2. A supersonic test vehicle or sled.

moving film to record 1,000-c and 100-c timing marks.

Of the seven Bowen cameras, four are used for track-side coverage to obtain trajectory data. Space-time information on the ejected object is also obtained from initiation of ejection to parachute deployment.

Targets are located in the field of view of these cameras for camera orientation. Bench marks which describe a base line for the range coordinate system are set at 100-ft intervals on the track girder. The nodal points of the lens are accurately located with respect to these bench marks. Three fiducial marks, recorded in the picture area, describe a base line for the camera coordinate system. This method of trajectory acquisition is similar to the systems used at other test bases but has the unique feature of a tracking Bowen camera that is locked on azimuth and roll and tracks on elevation. By locking the camera on azimuth and roll it is possible to obtain trajectory data without the necessity of a multiple camera setup.

On the desert floor and on the slopes of the mesa are three Bowen cameras that also record trajectory information. These cameras are aimed at a point in space and a unique method is employed for orientation. A Wild T-1 theodolite is mounted to the camera which is pointed at a known target (Fig. 3). This target is photographed and the camera is rotated on its horizontal and vertical axis to a predetermined point in space. The difference in azimuth and elevation readings from the targets to the point in space is used to calculate the orientation of the cameras. The high initial cost of a precision three-axis mount precluded its use, and so the more economical theodolite method of camera orientation was employed.

Attitude and event coverage is obtained by two tracking stations and numerous hand-held cameras dispersed at various positions. One tracking

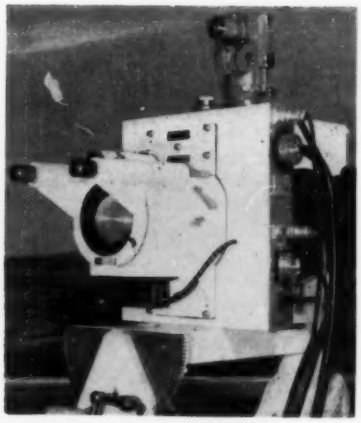


Fig. 3. Bowen CZR-1 Acceleration Camera with Wild T-1 theodolite mounted on the camera for "point in space" orientation.

station is located on a 75-ft steel tower situated 3,000 ft from the track. This station commands a view of the entire track and is used from first motion of the test vehicle to parachute deployment. The second station is a self-contained mobile unit that is equipped to operate at any practical position on the range (Fig. 4). The two stations are equipped with B-29 gun turrets and sighting stations and use 8-power binoculars for viewfinders. Mounted on each turret are three cameras, a High-Speed Mitchell, an Eastman High-Speed and a Bell & Howell Model 70 da. Frame rates for these cameras usually approached maximum since the duration of most tests is less than 15 sec.

"On-board" coverage is provided to record preliminary phases of the ejection such as hatch-release, windblast, seat and dummy ejection and braking action. To obtain such information, it is necessary to have the equipment on board the test vehicle. Also, since such action takes place in a short time, high frame rates are necessary.

The necessity of carrying "on-board" cameras has generated many problems because of the high acceleration and deceleration loads. Forces up to 60 g have been experienced during the braking phase of the vehicle in the water brake.

To date, three types of cameras have been tested; the GSAP, the Fairchild HS-100 and the Traid 200. The success obtained with these cameras ranges from poor to good.

The GSAP cameras used on the test vehicles are modified to better withstand the accelerations, decelerations and vibrations present on the track. This modification consists of removing all parts not essential for 64 frames/sec operation. The magazines were reworked by rerouting the film, increasing the tension of the take-up spool and relieving the pressure plate in the area of the feed

(This paper was received on September 5, 1956.)

terms of space coordinates and time, are

electrode is projected on the continuously

**Fig. 4. The mobile station, with three-camera turret.**

pawl. The drive-motor performance was improved by eliminating the governor and increasing the speed by installing a resistor in series with the field windings. Although these cameras have been greatly modified and tested under various conditions, the overall performance is rated as poor.

The Fairchild HS-100 was tested on two occasions with successful results. The camera was first run on a test at a speed of 800 ft/sec and a g loading of 25 maximum. The camera was mounted in the cockpit of the test vehicle. Excellent records were made of the preliminary ejection phases and the windblast on the face of the anthropometric dummy.

At the conclusion of the test, the camera was removed and inspected for operation and damage. The processed film was screened and camera operation was rated as excellent. There was no indication of damage to the camera but the focusing ring separated from the lens barrel despite the fact that the focusing ring and diaphragm were taped in position before the firing. Surprisingly enough, good focus and exposure were maintained throughout the test.

The second test with the Fairchild camera was made at a speed of 1200 ft/sec at a 10-g loading. The camera was mounted on the front axle of the vehicle and was subjected to severe vibration forces. The purpose of this test was to determine "slipper" action on a continuously welded rail. The camera operation on this test was rated as good but lens separation occurred in the second test as in the first test.

The power supply for the Fairchild FS-100 is a single dry cell $2\frac{1}{2} \times 3\frac{1}{2} \times 6$ in. and weighs $2\frac{1}{2}$ lb. Frame rate is regulated by supply voltage which is set by a selector switch. This simple and lightweight power supply has proved to be very convenient and easy to install.

The Traid 200 was run on two tests, at a velocity of 1200 ft/sec and a 40-g loading to determine windblast effects on an experimental oxygen mask. Camera operation was rated as good on both tests; however, the 200/sec frame rate is too low for sufficient time base expansion for detailed study.

On-board camera coverage at the project has been limited but it is recognized that event recording of the initial phase of ejection is becoming increasingly desirable. Vehicle mounted cameras are one of the best sources of this information. Other makes of cameras designed for extreme gravity and vibration forces are on the market or will be in the future and it is anticipated that these will be tested. Special mounts are in the design stage to determine the feasibility of using the Eastman High-Speed and the Fastax WF-100 for on-board coverage.

## Laboratory

In test work, it is often necessary to evaluate the results of one test before proceeding with another. Due to the remote location of Project SMART, a complete facility for processing was deemed necessary. The project laboratory is equipped to process black-and-white material and is capable of maintaining good quality control by sensitometric means.

The material most commonly used is the Kodak Linagraph Shellburst film. This material, although high in contrast, is adequate in granular structure to record the information desired. This film is machine processed to a gamma of 2.10. This high contrast is usually desirable when trajectory and kinematic measurements are made from the original negative.

## Conclusion

Coleman Engineering Co., under contract to the Air Force, designed, constructed and is operating this facility on a limited budget. In facing the many decisions which had to be made in the selection of equipment and methods, not *what was the best* but *what was the best method to do the job with limited funds* became the primary consideration. Also a part of the considerations was adaptability to expansion. The Photographic Dept. consists of five men who plan tests, operate and maintain cameras, process film and evaluate end results.

## Discussion

*Lt. Fred F. Meadows, Jr. (Ballistic Test Facility, AFAC, Edwards, Calif.)*: As regards the tracking Bowen Camera which is locked on azimuth and roll and tracks on elevation, how do you account for the orientation of this camera in the vertical axis?

*Mr. Krupp:* This camera, as are the other below-the-mesa cameras, is oriented by photographing surveyed targets, in this case targets located in the "recovery area." This defines a sector perpendicular to the elevation axis and originating at the nodal point of the camera lens. Trajectory reduction techniques consist of determining mathematically the intersection of the ray from the below-the-mesa cameras to the object and a vertical sector originating at the nodal point of the lens of the tracking Bowen and passing through the object.

*John Jacobs (Westrex Corp.)*: Would you care to say anything about the apparatus used for viewing and assessing film?

*Mr. Krupp:* Bowen film is assessed for trajectory measurements by a Gaertner Comparator which is a machine for measuring displacement of the object image from the fiducial or reference marks on the film. Trajectory is reduced by mathematical manipulation of these film measurements and camera orientations using desk calculators. Future plans call for a powered comparator for film measurements and IBM equipment for trajectory computation. Motion-picture film is viewed by a 16mm or a 35mm projector and Bowen film can be assessed for event coverage by means of a light table.

# Low-Frequency Noise Associated With Remote Television Pickups

## A joint Broadcaster/Bell System report sponsored by the Video Transmission Engineering Advisory Committee

*Representing the Network Broadcasters*

H. C. Gronberg, National Broadcasting Co.

J. Serafin, American Broadcasting Co.

W. B. Whalley, Columbia Broadcasting System

*Representing the Bell System*

J. Thorpe, A. T. & T. Co., Long Lines

H. P. Beckmann, N. Y. Telephone Co.

A. G. Coffin, A. T. & T. Co., Long Lines

J. B. Odell, Pacific T. & T. Co.

H. O. Saunders, Jr., A. T. & T. Co.

**Field conditions have shown that mobile TV units of the Broadcasters and the Telephone Co. present a low-frequency noise (hum) problem because of the difficult grounding conditions which prevail. The problem is increased by a requirement for large amounts of a-c power by the Broadcaster. Remedial measures have been worked out in cooperation with the Broadcasters and the Bell System. The report is typical of the work which is being carried on by the Video Transmission Engineering Advisory Committee (VITEAC) and its subcommittee known as the Network Transmission Committee (NTC). This is a joint committee representing Network Broadcasters and the Bell System.**

Experience has shown that many remote television pickups result in low-frequency noise (hum) being fed between a Broadcaster's mobile TV unit and Telephone Co. equipment over the coaxial interconnection. Both microwave and wire installations of telephone equipment have been involved. This report outlines grounding and isolation procedures which can be used as mitigation measures in connection with this problem.

The Broadcaster's pickup trucks contain a considerable amount of video equipment. As shown in Fig. 1, the supporting framework and chassis of the video equipment are normally connected to ground by a grounding wire. This wire, as well as the equipment chassis, is insulated from the a-c electric neutral. A leakage path between the electric neutral and chassis ground exists through the transformers and capacitors in the mobile equipment units. The Broadcaster's video chassis is normally metallically connected through the coaxial sheath to the chassis of the Telephone Co. installation.

The total a-c power required by the Broadcaster's truck may be as much as 30 kw. The power source may be either single-phase, three-wire or three-phase with the latter more to be desired. In three-phase systems it is common practice to use four-wire "Y" connected secondaries. The 115 volt load is taken from the "Points of Y" and the 4th or neutral wire. Ideally the load currents should be of equal magnitude so that the neutral wire will not carry current, but in practice this condition is seldom obtained. The a-c neutral at this point may, therefore, be several volts from a remote ground potential.

In a telephone installation the procedures for providing an equipment ground isolated from the secondary power neutral are identical to those of the Broadcaster. However, the power normally required by a telephone installation is in the order of ½ kw and the potential on the Telephone Co. a-c neutral is usually small by comparison with the potential on the Broadcaster's neutral.

### Remedial Measures

When low-frequency noise is experienced, the following remedial measures apply. They are listed in the approximate order of importance, but considerable latitude may have to be exercised to meet a specific situation:

*(1) Provide a low-resistance equipment ground to the Broadcaster's mobile unit*

Experience indicates that only a water pipe ground will be of sufficiently low resistance to be effective. Further, that a No. 4 or larger stranded conductor should be used. Reference can be made to the National Electrical Code for minimum size wire.

*(2) Provide a low-resistance ground for the Telephone equipment*

Similar to Step 1, a metallic water pipe should be used as the ground electrode if available. Assuming a water pipe ground, the Telephone equipment ground should be run to the same pipe as the Broadcaster's ground and within a few feet if possible.

*(3) Provide a low-resistance bond between the Broadcaster's unit and the Telephone Co. unit*

It is recognized that this bond will have

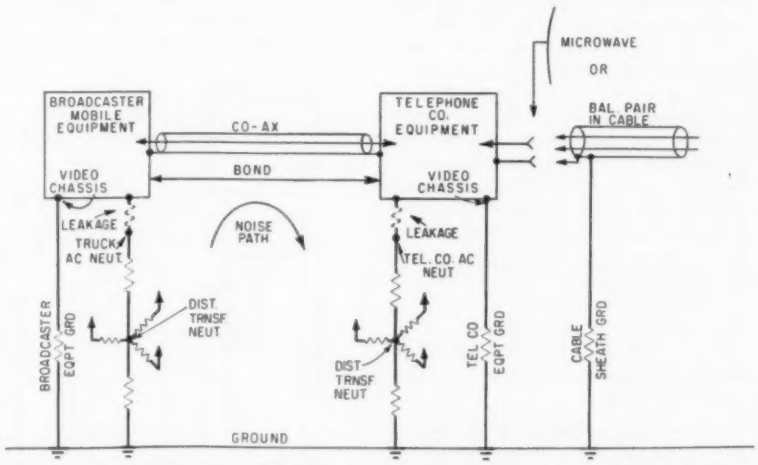
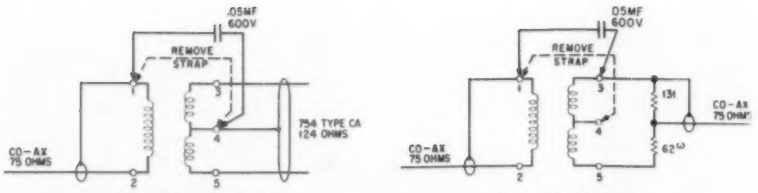



**Fig. 1. Normal ground connections for Broadcaster mobile unit and Telephone Co. equipment.**

The text of this report has also been separately published as NTC Engineering Report No. 1. Submitted as a contribution to the *Journal* on January 11, 1957, by Harry O. Saunders, Jr., American Telephone and Telegraph Company, 195 Broadway, New York 7.




(a) 75–124 ohms (b) 75–75 ohms

**Fig. 2. Emergency use of 197B Coil for video isolation. Note: Insulate shells of all jacks and plugs to remove minor shock hazard.**

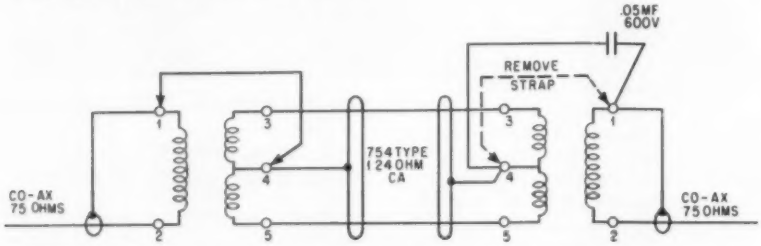



**Fig. 3. 75–124–75 ohms; emergency use of two 197B coils for video isolation.**

to be eliminated when the mobile unit and the telephone installation are separated by distances in the order of 100 ft or more. Also, when the same water pipe is used and short ground leads are possible for Items 1 and 2, this bond is unnecessary.

(*4*) *Balance the load on the secondary phases*

(*5*) *Arrange to feed the electric service of Broadcaster and Telephone Co. equipment from the same power distribution transformer. In addition, feed the Telephone Co. electric service from a receptacle on the Broadcaster's truck*

To facilitate the execution of this step the Broadcaster's Engineering representatives (ABC, CBS and NBC) are asking the affiliates to provide an electric receptacle on their mobile units for Telephone Co. use when this is feasible. A two-conductor twist lock receptacle, 15-amp capacity, will be provided by the Broadcaster unless other arrangements are requested. The RCA distribution box most commonly employed on mobile units will provide such a 2-wire receptacle. However, if local arrangements are already in effect to provide a 3-wire receptacle, there is no objection to this procedure provided the third wire commonly referred to as the "grounding conductor," together with metallically connected conduit, BX cable, etc., is isolated from the equipment grounds at either end.

(*6*) *Provide a clamper at the receiving end of the connecting cable*

(*7*) *Provide an isolation transformer in the 75-ohm coaxial line which joins the Broadcaster's truck and the Telephone Co. equipment (Figs. 2 and 3)*

In connection with the use of this step, the coaxial line should be kept as short as possible and where trouble is experienced a balanced pair should be extended to the Broadcaster's truck by means of a 754-type cable. This procedure will locate the 197B coil on the truck and will permit holding to a minimum the amount of unbalanced cable used to reach the Broadcaster's coaxial feed. If the Telephone Co. end of this interconnection also requires a 75-ohm unbalanced termination, a second coil as shown in Fig. 3 can be provided. A double coil arrangement would presumably apply only to microwave installations since most wire video systems give the option of a balanced input.

The Broadcaster will attempt to meet the requirements of Steps 1 and 4; the Telephone Co. will attempt to meet the requirements of Steps 2, 3, 6 and 7. Item 5 is a mutual problem requiring the cooperation of both parties.

## Discussion

*Isolation of chassis ground from a-c neutral*

The practice of isolating the chassis ground of video equipment from the a-c neutral is recognized for the reduction of low-frequency noise (60-cycle a-c, mainly) and is based on field experience. It is applicable to both Broadcaster and Telephone Co. mobile installations.

The leakage path between the a-c neutral and the chassis ground will normally be several hundred ohms. A fault in the electrical wiring or an installed strap between the two — either in Telephone Co. or Broadcaster units — will lower the impedance of the low-frequency noise path. In some mobile units also, there is a "truck ground" connection, and the experience is that this ground should also be kept separate from the electric neutral.

Where 3-wire electric receptacles are provided, the third wire or "grounding conductor" together with conduit, BX cable, etc., to which the grounding conductor is metallically connected, should be isolated from the equipment grounds at either end.

This isolation is necessary since the grounding conductor may be connected to the electric neutral on the supply side of the service entrance switch. The need for the isolation of electric neutral and the equipment grounds has been outlined above.

*Voltage on a-c neutrals*

The a-c power supplying the Broadcaster's truck is usually a three-phase load. If the load current in each phase is balanced, the neutral wire will not carry current, but in practice this ideal condition is not frequently realized. Therefore, current in the neutral wire returns to the power distribution transformer and to ground. The resistance of this path is small but finite and the a-c neutral connection at the mobile unit may, therefore, be several volts from ground potential.

Figure 4 schematically shows the currents and voltages of a typical remote pickup. The voltage to ground which exists on the Broadcaster's a-c neutral is equal to the voltage between the power system neutral at the distribution transformer and remote ground added to the voltage drop in the neutral conductor

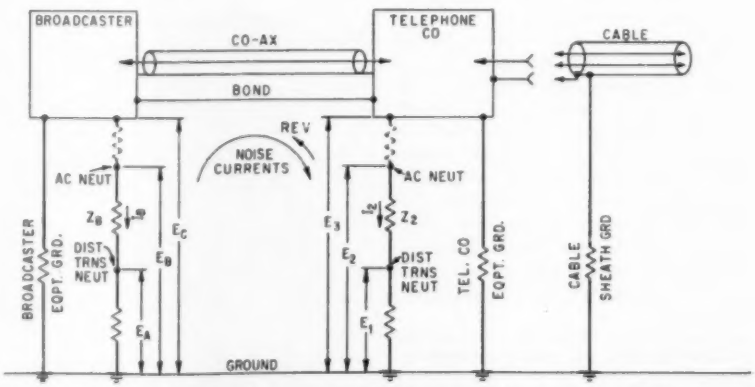



**Fig. 4. Voltages and currents associated with grounded structures of Broadcaster mobile unit and Telephone Co. equipment.**

which extends to the truck, i.e., $E_B = E_A + I_B Z_B$.

Since the total power consumed may be 30 kw, even a small load unbalanced will result in $I_B$ being several amperes. Further, it is not a simple matter to arrive at a balanced load, since the three in-phase and quadrature components of the current must be equal to make the resultant $I_B$ equal zero. Consequently, the $I_B Z_B$ voltage component is frequently several volts. A percentage of the voltage $E_B$ is fed through the leakage path to the chassis ground of the mobile units, and is shown as $E_C$.

*Noise paths*

A current from the Broadcaster's electric neutral is fed longitudinally through the leakage path to the Telephone Co. equipment ground and electric neutral. There is no suppression in this path and low-frequency noise may therefore result.

The current flowing on the coaxial sheath produces a small voltage at the input to the Telephone Co. equipment where the video amplifiers, which provide response down to a few cycles, amplify this voltage. Only specially designed terminals such as the A2A transmitting terminal or the A2 or A2A receiving terminals provide appreciable longitudinal noise suppression. Also the suppressing action of a clamper will be effective at 60 cycles and to a lesser extent at the second and third harmonics thereof.

A "reverse" longitudinal noise path exists from the Telephone Co. equipment to the Broadcaster's unit. However, since the potential on the Telephone Co. equipment ground is usually small, there will be few situations which produce an objectionable condition. The most common exception occurs when the telephone installation employs a single phase, electric feed, and this phase is also used for other high wattage equipment such as an electric heater to prevent icing of a parabolic antenna, etc.

*Need for adequate grounding*

The selection of a water pipe for the grounding electrode is extremely desirable. The metallic water pipe is the only commonly available electrode which provides low impedance to ground almost without exception. Ground rods and other second choice electrodes are frequently ineffective. Within buildings the ground wire should be attached on the street side of the water meter, or as an alternative, a bond around the water meter established.

The Broadcaster's Equipment Ground (Item 1) will provide a parallel path to ground with the longitudinal noise path from the Broadcaster's truck to the Telephone Co. equipment and a-c grounds. If the impedance of the ground wire to the mobile unit is low by comparison with that of the longitudinal noise path, the longitudinal noise path will in effect be "shorted out."

The low resistance ground to Telephone Co. equipment (Item 2) will short out the "reverse" longitudinal noise path described above. If a good ground is provided for Telephone Co. equipment but not for the Broadcaster's unit, the noise condition may, in some cases, be aggravated.

Items 1 and 2 will also be arrived at through the recommendations of the National Electrical Code.

The bond between video chassis of Broadcaster and Telephone Co. equipment (Item 3) permits the Telephone Ground (Item 2) to supplement the Broadcaster Ground (Item 1).

*Disadvantages of video isolation*

The video isolation transformer arrangements (Item 7) schematically shown in Figs. 2 and 3 are recommended with reservation because of the following inherent drawbacks:

(a) The video coil introduces some streaking and smearing. The phase correction networks may help to reduce these effects.

(b) The shield between the isolation coil and the Telephone Co. equipment must be left ungrounded, and may be considered an antenna for high-frequency noise pickup. Some improvements, however, may be expected by the use of the 0.05 μf capacitor between the coaxial shield and the telephone ground.

(c) There is no 75–75-ohm isolation coil available. Where this arrangement is needed either a 75–124-ohm coil and a resistance pad or two 75–124-ohm coils are required to do the job. The coil and resistance bridge introduce a 4–6-db loss and the gain to compensate for this loss may not be quickly available. The results may be either a nonstandard level at a point of interconnection and/or a noise impairment. The double coil, of course, multiplies the streaking and smearing mentioned above.

*Protection considerations*

In addition to the noise problem, an electric hazard exists if the equipment is left ungrounded and a fault occurs between an equipment chassis and the electric wiring. Further, even if no fault exists, an accident hazard may be present because the voltage on the Broadcaster's or Telephone Co. chassis may be perceptible to an individual's touch. Where mobile equipment is not grounded to a water pipe, it would, therefore, seem wise to use a voltmeter with insulated test picks or a neon indicator to test for an energized equipment chassis or housing before connecting the coaxial line to a mobile unit.

*Application of remedial measures to permanent installations*

This report is primarily concerned with low-frequency noise suppression associated with remote pickups. However, the remedial measures listed are equally applicable to permanent installations with the possible exception of video isolation (Item 7).

# Motion-Picture Standards

## Titles of Standards on Film Dimensions

Active work on developing a consistent set of descriptive titles for all film dimension standards was initiated in the fall of 1955. The subcommittee working on this project met during the 80th Convention in Los Angeles and devised the following system for titling these standards: Each title is to provide an indication of film width, pitch and perforation shape or number of rows of perforations, depending on which is the significant factor. This system was then applied to the existing standards and proposals in process resulting in the following titles:

PH22.34 Dimensions for 35mm Motion Picture Film, BH-1870
PH22.93 Dimensions for 35mm Motion Picture Film, BH-1866
PH22.36 Dimensions for 35mm Motion Picture Film, KS-1870
PH22.1 Dimensions for 35mm Motion Picture Film, DH-1870
PH22.102 Dimensions for 35mm Motion Picture Film, CS-1870
PH22.73 Dimensions for 35mm Motion Picture Film, Perforated 32mm, 2R-2994
PH22.71 Dimensions for 32mm Motion Picture Film, 2R-3000
PH22.72 Dimensions for 32mm Motion Picture Film, 4R-3000
PH22.12 Dimensions for 16mm Motion Picture Film, 1R-3000
PH22.5 Dimensions for 16mm Motion Picture Film, 2R-3000
PH22.110 Dimensions for 16mm Motion Picture Film, 2R-2994
PH22.109 Dimensions for 16mm Motion Picture Film, 1R-2994

The letter symbols denoting perforation shape have significance for workers in the field and stand for those who developed the particular perforation: BH = Bell & Howell, KS = Kodak Standard, DH = Dubray-Howell, CS = CinemaScope. The symbols 1R, 2R and 4R indicate the number of rows of perforations.

Subsequent to the meeting, the parent Film Dimensions committee, by letter ballot, voted approval of this nomenclature system and the above titles. They, therefore, will be the titles which will be used with the standards as they come up for future review. Two standard, Ph22.-34-1956 and PH22.102-1956, have already been approved as American Standards with these new titles.—*Henry Kogel*, Staff Engineer.

## Revisions of American Standards

A proposed revision of American Standard PH22.87-1953 is published here for a three-month period of trial and criticism.

This proposal differs from the 1953 standard in several ways but in only one essential: the deletion of the specification of the picture-sound separation. The basis for this modification was twofold: Firstly, developments in the field of magnetic recording and the growing applications of this recording medium led to divergence in national practice from the 26 frame separation established initially in 1950. Secondly, international opinion was not receptive to the 26 frame specification. In reviewing this situation, the Sound Committee decided that it would be preferable to convert PH22.87 into solely a magnetic coating standard and to establish a separate standard for the sound record specifications. This has now been done and a new proposal containing a 28 frame picture-sound separation specification is being processed.

The additional modifications include a change in format and an indication of the optional use of a balance stripe on the perforated edge.

A proposed revision of American Standard PH22.73-1951 is also published for a three-month period of trial and comment.

This proposal differs substantially from the 1951 standard:

1. A new format is employed which provides a scope and numbered specifications.
2. The scope now limits the application of this standard to low-shrinkage safety film.
3. The perforation pitch is reduced from 0.3000 in. to 0.2994 in.
4. The method of indicating the permissive angular misalignment of the perforations (dimension G) is brought into conformity with the more recent film dimension standards.
5. The new title is part of the consistent set of titles for all dimension standards just developed and approved by the Film Dimensions Committee.
6. Changes in the notes and appendix are designed to add clarity to this proposal.

It should be noted that this proposal still specifies negative-type film. A similar positive-type film with a 0.3000 in. pitch was and still is being manufactured. However, this positive film was not and still is not covered by an American Standard. All such negative film is now being manufactured with the smaller pitch specified in this proposal.

All comments should be sent to Henry Kogel, SMPTE Staff Engineer, prior to May 15, 1957. If no adverse comments are received, these proposals will then be submitted to ASA Sectional Committee PH22 for further processing as American Standards.—*H.K.*

Proposed American Standard

### 100 Mil Magnetic Coating on 16mm Film, Perforated One Edge

**PH22.87**

Rev. PH22.87-1953

#### 1. Scope

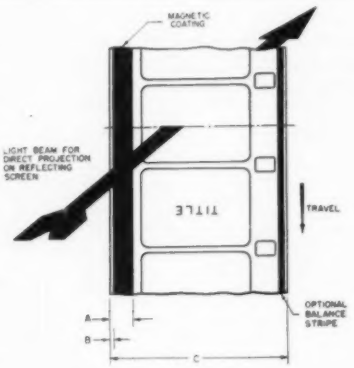
**1.1** This standard specifies the location and dimensions of the magnetic coating applied to 16mm motion-picture film with perforations along one edge. This film is used for both picture and sound.

#### 2. Dimensions and Location

**2.1** The dimensions shall be as given in the diagram and table.

**2.2** The magnetic coating shall be on the side of the film toward the lamp on a projector arranged for direct projection on a reflection-type screen.

**NOTE:** The balance stripe is optional and may be a magnetic coating or another material of the same thickness.




| Dimension | Inches | Millimeters |
|---|---|---|
| A | $0.100 \begin{smallmatrix}+0.005\\-0.000\end{smallmatrix}$ | $2.54 \begin{smallmatrix}+0.13\\-0.00\end{smallmatrix}$ |
| B | 0.005 max | 0.13 max |
| C | 0.628 nom | 16 nom |

NOT APPROVED

Proposed American Standard

# Dimensions for 35mm Motion-Picture Film, Perforated 32mm, 2R-2994

PH22.73

Rev. PH22.73-1951



## 1. Scope

**1.1** This standard specifies the dimensions of 35mm negative motion-picture film perforated for eventual use as 32mm motion-picture film.

**1.2** These dimensions pertain to a safety film with low-shrinkage characteristics as defined in Appendix 1.

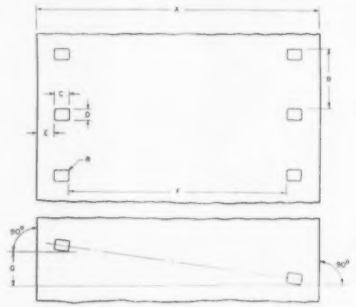
## 2. Dimensions

**2.1** The dimensions shall be as given in the diagram and table.

**2.2** These dimensions apply to negative raw stock immediately after cutting and perforating.

**2.3** In any group of four consecutive perforations, the maximum deviations from aim pitch shall be held to a value as much smaller than 0.001 in. as can be obtained. This is desirable because of the beneficial effect on steadiness thus realized.

**2.4** Dimension L represents the length of any 100 consecutive perforation intervals.



| Dimension | Inches | Millimeters |
|---|---|---|
| A | 1.377 ± 0.001 | 34.98 ± 0.03 |
| B | 0.2994 ± 0.0005 | 7.605 ± 0.013 |
| C | 0.0720 ± 0.0004 | 1.829 ± 0.010 |
| D | 0.0500 ± 0.0004 | 1.270 ± 0.010 |
| E | 0.096 ± 0.002 | 2.44 ± 0.05 |
| F | 1.041 ± 0.002 | 26.44 ± 0.05 |
| G | 0.001 max | 0.025 max |
| L | 29.94 ± 0.03 | 760.5 ± 0.8 |
| R | 0.010 | 0.25 |

NOT APPROVED





### NOTES

1. The dimensions in the inch system are the fundamental standard. The dimensions in the metric system are practical approximations based on American Standard B48.1-1933, reaffirmed in 1947, providing a conversion factor of 1 inch = 25.4 millimeters.

2. The title of this standard was established by the application of a nomenclature system developed for all film dimension standards: Each title provides an indication of the film width, the perforation pitch (without the decimal point) and the perforation shape (BH, KS, DH or CS) or number of rows of perforations (1R, 2R or 4R), depending on which is the significant factor.

3. The fundamental difference between this standard and its 1951 predecessor is in the decrease in the values for dimensions B and L, which were specified respectively as 0.3000 ± 0.0005 in. and 30.00 ± 0.03 in.

### APPENDIX 1

For the purpose of this specification, low-shrink film base is film base which, when coated with emulsion and any other normal coating treatment, perforated, kept in the manufacturer's sealed container for six months, exposed, processed and stored exposed to air having a temperature of 65 F to 75 F, 18 C to 24 C, and a relative humidity of 50% to 60%, for not more than 30 days, and measured under like conditions of temperature and humidity, shall have shrunk not more than 0.2% from its original dimension at the time of perforating.

### APPENDIX 2

This kind of 32mm film is made on 35mm stock so that it may be processed on 35mm sprocketless developing machines.

### APPENDIX 3

To comply with ¶1.2, this film is made on safety base complying with American Standard PH1.25-1956, Safety Photographic Film. Nitrate film should not be used because this film may be slit to the 16mm width and used on 16mm projectors with subsequent danger of fire.

### APPENDIX 4

Films which after processing are intended to pass through a continuous contact printer in which the exposure is made over a cylindrical surface do not yield prints of maximum steadiness unless the actual pitch of the film curved to the smaller radius (the "negative") is slightly less than that of the film curved to the larger radius (the "print stock"). Since positive films in general are perforated to a nominal 0.3000 in. pitch and since negative-type films with low-shrinkage characteristics do not shrink enough for optimum pitch relationship with such positive films, the nominal 0.2994 in. pitch was developed for films to be used primarily as negatives for the subsequent production of prints. They also find other specialized uses.

NOT APPROVED

# news and reports

## 81st Convention

Plans for the 81st Convention are now entering the final stages of preparation and full details to date will soon be ready for announcing in the postal notice that will go out to members at the end of February. Two statements can be made with a high degree of certainty. One is that it will be exciting and the other is that the emphasis will be on new trends, new developments and new equipment.

In a rapidly changing world for which man is making satellites and where the world of color in motion pictures and television is extending to new dimensions, the Society is keeping pace with technological advances.

The Symposium on Missile Photography seems to be attracting considerable attention not only throughout the industry but from that segment of the general public that is alert and aware of significant developments and a large attendance is anticipated. Sidney M. Lipton, Manager of Optics Engineering for RCA Service Co. at Patrick Air Force Base, Cocoa, Fla., is organizing this session and anyone having a specific contribution in this area should contact him without delay. Overall responsibility for high-speed photography is in the hands of John Waddell, the announced Topic Chairman. He is actively organizing a general high-speed photography session.

With a program built around important advances in several areas rather than centered on one phase, it is difficult to pick out highlights or to describe any one session as "more" or "most" important.

Some stimulating sessions on Audio-Visual Uses of Motion-Picture and Television are shaping up and one unusual session will be conducted at Walter Reed Hospital. The session will be held at the Armed Forces Institute of Pathology, Walter Reed Medical Center. There will be a paper on their color film processing laboratory as well as a paper on the closed circuit color TV installation (the biggest of its kind). The session will include demonstrations of TV production and its various applications, and a guided tour of the Center. Some of the papers already lined up for the audio-visual sessions are:

Magnetic Recording and Transfer for European Productivity Agency Films, by John Seabourne, EPA, Paris, France

New Method to Record 16mm Magnetic Lip-Synchronized Sound, by Lee Askren and Ray Dwyer, Apparatus and Optical Div., Eastman Kodak Co., Rochester, N.Y.

Teaching by Closed-Circuit TV, by Harvey Zorbaugh, Communication Arts Group, New York University.

Economic Impact of the Audio-Visual Field, by John Flory, Advisor on Nontheatrical Films, Eastman Kodak Co., Rochester, N.Y.

Low-Cost Projection Materials and Techniques, by Harvey Frye, Indiana Univ., Bloomington, Ind.

One of the Society's strongest and most productive areas of endeavor has been in the establishment of standards and one entire session will be given over to the topic of "Standards and Standardization."

The Ladies Program will feature many events of special interest to wives of members and is planned to take full advantage of Springtime in the Nation's Capital. One "coeducational" event is the Monday evening session which will feature the showing of an historical film and a review of the great events of the past. The topic is "Industry Milestones" and the session will hold considerable interest for members and their wives. There will be a tour of both houses of Congress, with luncheon in the Supreme Court Room where President Eisenhower lunched on Inauguration Day. Other attractions planned include a visit to the religious shrines, tea at one of the embassies, and a guided tour of the White House.

At the last two or three Conventions held in Washington, suggestions were made that a pleasant end to the Convention might be a visit to Williamsburg and some of the picturesque sights of Colonial Virginia. If there is sufficient interest, this will now be possible. Arrangements have been made with Travel-Inc., 1001 Connecticut Ave., N.W., Washington, D.C., for a choice of tours, one a two-day tour to Fredericksburg, Richmond, Williamsburg, Jamestown, Yorktown and Stratford, including an overnight stay at the Williamsburg Inn, for $68 per person; the other a three-day tour to roughly the same areas, for $64 or $84 per person, depending on the hotel accommodation. It will be necessary for at least 25 people to sign up in order for the tours to be definitely scheduled, and those interested should send their requests directly to Travel-Inc. by April 10. Full details about the tours can be obtained from Travel-Inc.

### Hotel Reservations

Room reservations should be addressed directly to the Reservations Manager, Shoreham Hotel, 2500 Calvert St., N.W., Washington, D. C. They may be made ahead of time, or by using the card attached to the postal notice. Room rates are as follows: single room with bath— $11.00 daily; double room with bath — $15.00; living room, bedroom and bath — $25.00.

### Equipment Exhibit

Equipment manufacturers and dealers are taking full advantage of this show's strategic location and orders for space have been coming in fast. Already, in the brief time since the announcements went out, half the booths have been contracted for, and it evidently will not be long before the full house sign goes up.

This is no real surprise. Washington is always an attractive place for those who have new developments to offer in any of the electronic fields and there are many among the exhibitors at recent SMPTE conventions who will find this a profitable opportunity.

Since the notices about the exhibit were sent out, the Shoreham Hotel has been doing some redecorating and, in the process, has cut out some of the space that was to have been available for booths. This means that those booths shown on the floor plans as Nos. 1–4 and 15–31 have had to be eliminated, reducing the total number of booths available from 59 to 38. However, these will now be most attractively arranged in newly decorated quarters. Since their number has had to be reduced so drastically, though, space orders that are delayed too long are likely to be too late.

Like the Shoreham Hotel, Walt Trimby, the Exhibit Chairman, reports that he too has changes to announce. As of March 1, he will be moving from Washington to Atlanta, and turning over his chairmanship to Fred Gerretson, of Du Pont. Last minute inquiries or orders therefore should be addressed to Walter W. Trimby, c/o Sylvania Electric Products, Inc., 2520 Oakville St., Alexandria, Va., up to February 28; after that date they should go to Fred W. Gerretson, c/o E. I. du Pont de Nemours & Co., National Press Bldg., Washington, D.C.

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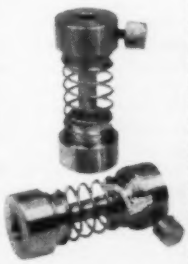

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## Biographical Note

### John I. Crabtree Retires From Kodak Research Laboratories

The internationally known authority on photographic chemistry, John Ickeringill Crabtree, retired from the Eastman Kodak Company on January 1, 1957. He was an Assistant Head of the Applied Photography Division of the Kodak Research Laboratories. He had joined the Laboratories in 1913, shortly after he completed his work in England for a Master of Science degree.

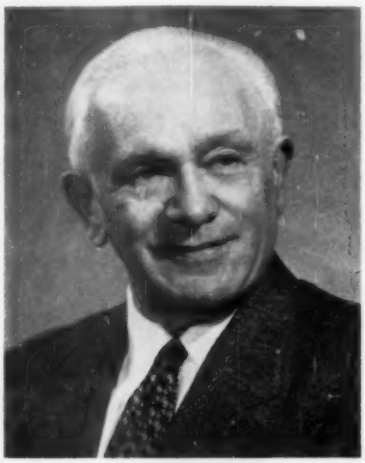
At a retirement dinner held on December 18, 1956, at the Monroe Golf Club, Pittsford, N.Y., his services to the field of photographic chemistry were extolled by members of the Laboratories' staff and by letters from his many friends throughout the world. Among the letters read at the dinner were a number from former officers of the SMPTE as well as members of the present Board of Governors.

Well-known for more than 35 years as an active member and Fellow of the Society of Motion Picture and Television Engineers, Mr. Crabtree has served on many committees, the Board of Editors, the Board of Governors and finally as President in 1930–32. His work on the Board has always been highly regarded by his associates. He played an important part in the establishment of the Society's *Journal* in 1930 and constructively built up the reputation of the *Journal* as one of the leading engineering publications of the world during his term as Chairman of its Editorial Board. During his two-year term as President of the Society, he actively supported the growth of the membership and improved the Society's financial position by the establishment of sustaining memberships within the motion-picture industry. He also encouraged a closer liaison with the Motion Picture Research Council, the American Standards Association, and other engineering organizations.

John I. Crabtree was born on March 27, 1891, at Clayton-le-Moors, Lancashire, England. He received his basic scientific training at Victoria University, Manchester, England, where he was granted a Bachelor of Science degree with honors in chemistry in 1912, and a Master of Science degree in 1913. He also passed the requirements of the Institute of Chemistry of Great Britain and Ireland, the leading professional chemical body in England, and was made a Fellow of that Institute in 1913.

In August 1913, Mr. Crabtree was employed by the Eastman Kodak Company at Rochester, New York, as a research chemist in the Kodak Research Laboratory, which had been founded in 1912 under the directorship of Dr. C. E. K. Mees. He founded the photographic chemistry department in 1913. From 1916 to 1938 he also was in charge of the motion-picture film developing department. As head of these departments, he was responsible primarily for research on photographic processing in all its aspects, including the evolution of processing formulas and systems, studies of the chemistry of development and fixation, the use of desensitizers, the causes and elimination of stains and markings on photographic materials, the tinting and toning of lantern slides and motion-picture films, the corrosive effect of photographic solutions on photographic apparatus, tropical processing, silver recovery, compounding of package chemicals, storage of photographic records, effective methods of washing photographic materials, and the technique of motion-picture processing. On this last-named subject, to which he has devoted much of his attention, Mr. Crabtree has published 55 papers. He has also supervised research in the rapid processing of films and papers and in special methods of processing.

All told, he has been author and coauthor of some 160 papers and has been granted 35 United States patents, covering a wide variety of subjects. His articles have been published in many countries and several have been reprinted as handbooks. He is coauthor with G. E. Matthews of two



books, *Herstellung Photographischer Lösungen* (W. Knapp, Halle, Germany, 1929), and *Photographic Chemicals and Solutions* (American Photographic Publishing Co., Boston, 1939).

While his interests have covered the range from the exposure of negative materials to the preservation of the finished photograph for archival purposes, his main field of work has centered on the operations of chemical processing and the methods and equipment with which it is carried out. The many papers on this subject have not only elucidated the chemistry of processing reactions but have provided complete specifications of materials, formulas and procedures for the many fields of practice. Other papers have dealt with measurement of the results of processing and the diagnosis of troubles with practical information on the prevention or remedy of faults in photographic records. His papers constitute the principal source of information on many of these subjects.

A number of Mr. Crabtree's papers have proved so useful to photographers in this country and abroad that they have been revised and reprinted many times. For example, his article "Stains on Negatives and Prints," originally published in 1921, has been in constant demand for thirty-five years as a primary reference on the subject.

A large proportion of the proprietary packaged chemicals sold by the Eastman Kodak Company are based on formulas worked out under Mr. Crabtree's supervision. A particularly significant piece of research which he has carried out with important results concerns the chemistry of the stop bath and especially of the fixing bath. Recently very valuable work has been done in his department on agents for "sequestering" calcium and iron in developers, on single powder developers, on replenishment systems for developers, on stabilization processing, and on high temperature and rapid processing.

In the field of photographic equipment, Mr. Crabtree has shown leadership in fostering basic, practical designs for the application of photographic chemical and motion-picture processes. Such equipment includes portable apparatus for development of motion-picture film at normal and high temperatures, various motion-picture laboratory apparatus, such as timers, waxing machines, pneumatic squeegees, title-making apparatus, storage cabinets for motion-picture film, and rapid processing equipment.

Mr. Crabtree is a Fellow of the Royal Photographic Society (London), of the American Association for the Advancement of Science, the Society of Photographic Engineers, and of the Photographic Society of America. He is a member of the American Chemical Society, the Optical Society of America, and the Academy of Motion Picture Arts and Sciences. He is an Associate of the Oval Table Society (an honorary photographic society).

Numerous honors have been awarded to Mr. Crabtree for his research work. With Dr. M. L. Dundon in 1924 he received the Progress Medal of the Société Française de Photographie for outstanding research work in photography and for publication on the causes of fog in developers. In 1944 with G. T. Eaton and L. E. Muehler he received the Journal Award of the Society of Motion Picture Engineers for the most outstanding paper published in the *Journal* of the Society during the year 1943. Also in the year 1944 he was the recipient of the Henderson Award of the Royal Photographic Society for outstanding contributions to photographic processing. Then in 1950 his paper on "Rapid Processing of Films and Papers" was voted the most outstanding technical paper published in the *PSA Journal* for the year 1949, and for this he was given the first Journal Award of the Technical Division of the Photographic Society of America. In 1952, he was awarded the Gold Progress Medal of the Society of Motion Picture and Television Engineers "for his outstanding contribution in the fields of photographic chemistry, motion-picture processing and processing equipment." The Photographic Society of America granted him their highest honor, the Progress Medal, in 1956.

During World War I, Mr. Crabtree was a civilian instructor in the Army School of Aerial Photography at Rochester, N.Y. In World War II, he and members of his staff gave valuable assistance on photographic processing problems to the Army Signal Corps and the Air Force. He also helped the National Archives and the Library of Congress in connection with problems of restoration and preservation of valuable photographic records. On several occasions he assisted the Federal Bureau of

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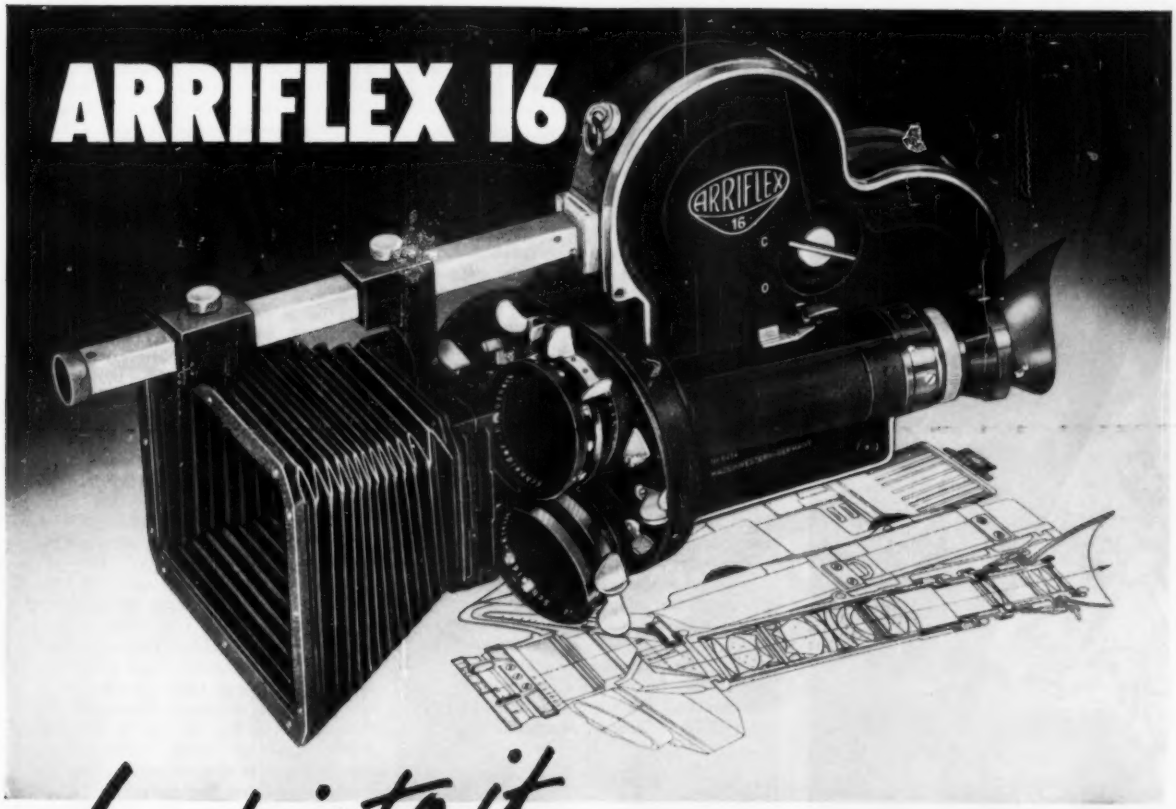


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Investigation on problems related to photographic chemistry.

In December 1938, Mr. Crabtree became actively associated with the American Standards Association as a member of the Sectional Committee Z38 on photography. When this work was reorganized in 1950 and the original Sectional Committee replaced by four new Sectional Committees, Mr. Crabtree was named the chairman of one of these, PH4 — Processing. A record of close to 90 approved American Standards in the field of photographic processing were revised and initiated under his leadership while heading this committee. On December 3, 1956, he was presented a hand-illuminated scroll by the A.S.A. at a dinner in New York City honoring him for his outstanding services to that organization over a period of 18 years.

In 1924 Mr. Crabtree became a naturalized citizen of the United States. In private life he describes himself as a farmer and resides on Canandaigua Lake near Middlesex, N.Y., where he takes a lively interest in the affairs of the township.

For more than forty-three years, John I. Crabtree has worked diligently at his chosen profession of photographic chemistry. Much of the advancement of knowledge of general photographic chemistry and motion-picture processing reactions and techniques can be traced directly to his researches and that of colleagues under his supervision.—*Glenn E. Matthews.*

## Film Storage

A report on "Fire Effects and Fire Control in Nitrocellulose Photographic Film Storage" has been prepared by the National Bureau of Standards.

The report presents the findings of an inter-agency committee appointed to conduct an extensive investigation into the hazards involved in the storing of nitrocellulose film with recommendations for safety measures.

The inter-agency committee, composed of representatives from government and private organizations, such as the National Archives, Department of Defense, Motion Picture Association of America, and the National Automatic Sprinkler and Fire Control Association, limited its investigation to the problems of storage of nitrocellulose film.

A booklet prepared by the Eastman Kodak Co. extends the field of inquiry to include the problems of storage of acetate or "safety" film. The booklet, entitled "Hazard in the Handling and Storage of Nitrate and Safety Motion Picture Film," may be obtained at no charge from the Eastman Kodak Co., Motion Picture Film Dept., Rochester 4, N.Y. A supplemental pamphlet now in preparation reports on "The Preservation of Nitrate and Safety Motion Picture Film."

As part of the Bureau of Standards investigation, a vault was constructed near Beltsville, Md., and an experimental program set up to investigate the effects of such factors as film containers, racks and sprinklers, to film load and venting.

The 20-page Bureau of Standards report gives a full description of the experiments carried out and procedures used, together with recommendations for special situations. Conclusions generally are: (1) Each vault for the storage of nitrocellulose film should be provided with a vent of sufficient area to prevent the development of dangerously high pressures during a fire. (2) With closed-front compartmented racks and a film load of 5 lb/in. of vent area, pressures as high as 0.25 lb/in. were observed. Vaults, including doors, should be designed for such pressure, when they are to be equipped with such racks. (3) If open-front compartmented or skeleton film racks are employed and the film load kept at or below 5 lb/in. of vent area, pressures as high as 1.0 lb/in. may be developed during a fire. (4) Temperatures observed were sufficiently high that only masonry or other equally noncombustible construction should be used for film vaults. (5) The film should be stored in close-fitting metal cans or containers giving equal protection, placed on racks within the vault. (6) The film may be completely destroyed unless the vault is equipped with closed-front insulated compartmented film racks or adequate automatic sprinkler protection. The closed front compartmented racks employed should be so constructed to prevent the spread of fire from one compartment to another. By adequate sprinkler protection is meant one sprinkler head, preferably of the directed-spray type, for each 60 ft of vault. (7) The minimum destruction of film was obtained by the use of closed-front compartmented racks and automatic sprinklers of the directed-spray type.

Additional recommendations for property protection are: (8) The film in a vault or group of vaults represents a hazard to the surroundings so that vaults should be located where they may be expected to remain isolated from valuable property. (9) The vaults used should be equipped with vertical vents or means to deflect the discharge in a vertical direction. The minimum dimension of the vent should be greater than the maximum dimension of the film containers to be stored. The throat edges of the vent should be beveled or funneled at approximately 45° to prevent film containers sticking in and partially reducing the vent opening. (10) Any cover on the vent should be so designed and constructed that it will open before the internal pressure rises to 0.25 lb/in. (11) Any device such as electric or heating equipment that might ignite film should be placed and enclosed in such a manner that contact with film is not possible.

The Eastman Kodak project undertook to answer such questions as: (1) Will safety film burn? (2) In the event of a fire, does safety film give off gases which are poisonous or explosive? (3) What precautions are required in handling and storing safety film from the point of view of hazard? (4) How can safety film and nitrate film be readily distinguished?

The Eastman researchers found that safety film presented a minimum hazard in handling and storage. The real danger, they found, was that nitrate film might be mistaken for safety film when the two types are used by the same studio.

The Bureau of Standards publication may be purchased for 20 cents by addressing: Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.—*R.H.*

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## Industry, Education News

**The Projectionist Information Committee,** newly formed by the Society, was described in a report presented to the Board of Governors on January 25, by Ralph H. Heacock, Committee Chairman. Mr. Heacock, who is Theater Equipment Product Manager of the RCA Victor Division, described the Committee's plans for 1957 and outlined proposed methods for keeping motion-picture projectionists informed of new developments in the industry, stating "... leading industry engineers will be invited to submit articles which deal with specific problems which projectionists must face with the new techniques. These articles will be carefully reviewed by the committee in order to insure factual, impartial information."

Plans for committee activity include having the articles printed in the quarterly bulletin of the IATSE and in industry trade papers. More detailed information may be made available as reprints.

The committee will be in continuous contact with Hollywood studios and with the Motion Picture Research Council to insure dissemination of information on any new techniques so that the men actually responsible for putting on the show will have pre-release information on new techniques even before prints are available for projection in their booths.

In addition to Mr. Heacock the committee will have two vice-chairmen: Merle H. Chamberlin, Chief Projectionist at M-G-M Studios, and Gio Gagliardi, Director of the Sound and Projection Department of the Stanley Warner Management Corporation.

Committee members are: John W. Bantau, Chief Engineer, Fox West Coast Agency Corp.; Willy Borberg, Head of the Mechanical Engineering Dept., General Precision Laboratory; Robert P. Burns, Sound Director, Balaban & Katz Corp.; Lawrence W. Davee, Sales Manager and Engineer, Century Projector Corp.; John Forde, IATSE Representative, Palo Alto; Charles F. Horstman, Chief Projectionist, RKO Theatres; William F. Kelley, Manager of the Motion Picture Research Council: John J. Kohler, Projectionist, Loew's Theatres; Hugh McLachlan, Theatre Circuit Supervisor, Y & W Management Corp.; Richard Orear, Purchasing Agent, Commonwealth Theatres; Lucian E. Pope, Purchasing Agent, Fox Midwest Amusement Corp.; Frank H. Riffle, Theatre Sound Engineer, Motiograph, Inc.; and James C. Skinner, Sound and Projection Engineer, Interstate Circuit, Inc.

After a preliminary meeting of the committee in February for preparation of an agenda, there will be a meeting of the full committee during the Society's 81st convention at the Shoreham Hotel in Washington, D.C., April 29 – May 3.

## Transatlantic Television?

As the maximum phase of the 11-year cycle of sunspot activity approaches, there is considerable interest in the possibility of receiving television programs from the other side of the Atlantic.

The British Information Services report that some success has been achieved by the National Broadcasting Co. in the resolution of recognizable pictures from the British Broadcasting Corp. television transmitters at Crystal Palace, London, using a British receiver and a special aerial system at NBC's receiving station at Riverhead, Long Island.

In London, the BBC has been keeping a watch on U.S. TV channels in order to screen for its viewers any pictures that might be received. Some signals have in fact been received intermittently, but it has not been possible as yet to resolve any kind of a picture.

The reception depends upon the maximum usable frequency (m.u.f.) which is rarely high enough to sustain propagation across the Atlantic at the frequencies used by television transmitters. However, around the sunspot maximum period there are occasions when the m.u.f. rises into the 40-mc region and even, though much less often, into the 50-mc region. At these times the lowest frequencies used for television in the U.K. (45-mc, vision; 41.5-mc, sound) may be receivable in the United States. The reception of reasonable pictures is a more difficult matter because of multi-path reception which causes ghosting.

The frequencies quoted above are shared by two television stations in the United Kingdom: the Crystal Palace station in London (e.r.p. 120 kw) which is likely to provide the predominant signal, and Divis in Northern Ireland (e.r.p. 12 kw). Both normally radiate the same program.


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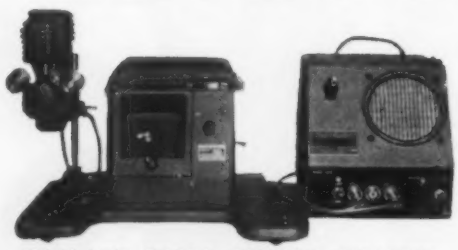

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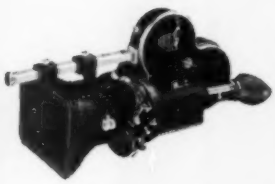

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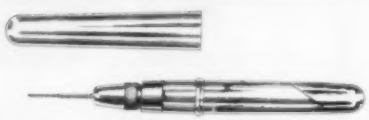

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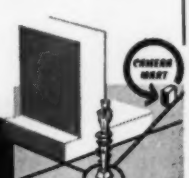


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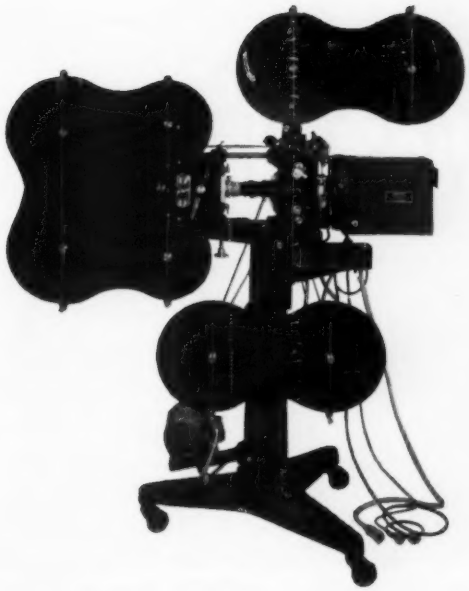

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Reception of U.S. television transmissions in Britain is very much more difficult because the lowest frequencies used are those of Channel 2, 54–60 mc. Furthermore, these are shared by several stations, not necessarily radiating the same program, which makes the multi-path problem acute.

As the sunspot maximum approaches, m.u.f.'s have risen rapidly. In October 1956, the m.u.f. for the transatlantic circuit averaged 38.4 mc at noon Greenwich Mean Time. In November this had risen to 44.6 mc, and in December to 45.4 mc. Long-distance reception from the United States was good throughout December. Broadcasts on 26 mc were received on 29 days and U.S. amateurs on 50 mc were received on 11 days. Many other signals on frequencies between 30 and 50 mc were received, and there was occasional reception on 56 mc.

Observations are continuing at the BBC's receiving station at Tatsfield, Surrey, where an RCA receiver is installed ready for use if the reception of actual pictures seems likely. A second RCA receiver is installed at Alexandra Palace, in London, where there is direct connection with the BBC's television network.

### Film for Television

The subject of motion-pictures on TV is still an extremely live topic. If a few of the more pessimistic and more sensational columnists are to be believed, both industries are on a one-way track to oblivion as a result of the sale of motion-picture libraries to television (*Journal*, Sept. 1956, pp. 518–519).

"Television is on the defensive in the United States," said Leonard Coulter, New York correspondent for the *British Kinematograph Weekly* (December 13). "For months," he said, "there have been the clearest signs of a slackening of public enthusiasm for television and a marked reawakening of interest in film. . . . Those who keep their noses close to the ground say there is a possibility — though not yet a probability — that within the next few years TV programming will move into the film industry's control, though the processes of transition are by no means apparent. It could be brought about by, for example, viewers and advertisers demanding more and newer backlog films. . . . " That's Mr. Coulter's opinion.

On the other hand, Lloyd Shearer recently asked in *Parade*, "Is Hollywood committing suicide?" Other columnists have cited depressing statistics on the closing of neighborhood motion-picture theaters ("closing in droves," one columnist said) and have pointed out that the large studios are, year by year, cutting down the number of pictures produced. Those trends are related, the columnists apparently believe, to the showing of old films on TV.

Vincent Canby in an article, "Major Films on TV Emerging as Vital Problem for Two Industries," in the *Motion Picture Herald*, January 19, seemed inclined to believe that there is no great cause for alarm although he sets out to uproot any idea anyone might have that there is anything academic about the question of what effect old Hollywood films will have on TV.

In an article full of "ifs" he implied that there is considerable freewill involved in the course of events. "If the matter of major company films on television is an academic question," he said, "it is an extremely lively one — and one whose answer will depend on such academic considerations as the future course of the television industry itself, as well as theater showmanship, theater operation and product supply. Why bring the subject up again?" asked Mr. Canby, apparently becoming suddenly tired of the whole thing. It is possible that others share his ennui—*R.H.*

**Use of closed-circuit TV** is the predication for saving at least $500 million dollars annually in teachers' salaries in public education throughout the nation. Dr. Alexander J. Stoddard, former Superintendent of Schools in Los Angeles, is the authority in a report, "Schools for Tomorrow: An Educator's Blueprint," prepared for the Fund for the Advancement of Education, an independent organization established by the Ford Foundation. Advantages to both teachers and pupils would result from an extensive use of closed circuit TV in the nation's public schools, according to Dr. Stoddard, who also points out that by reducing the number of teachers required at public school level it would be possible to raise salaries to professional levels at a reduced cost to the taxpayer while increasing the quantity and quality of instruction given to the pupil.


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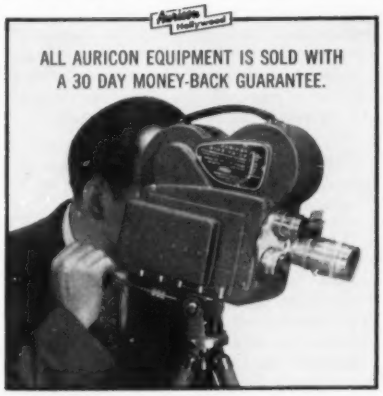


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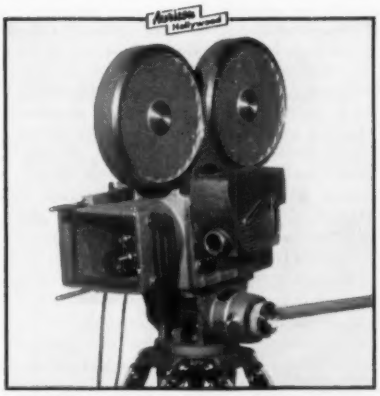

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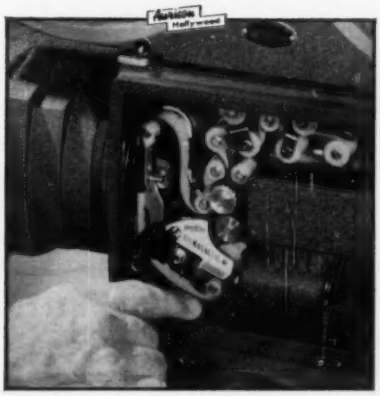

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# section reports

## Elements of Automation

At the November 1956 meeting of the Hollywood Section of SMPTE, which was held at Paramount Sunset Corp., November 20, Phil Adamson, Senior Staff Engineer, Hughes Systems Development Laboratories, Hughes Aircraft, gave a tutorial talk on automation. Mr Adamson's talk was fundamental in nature and was presented on a relatively nonengineering level in order to show the simple principles of computers and how they can save time and labor. Following Mr. Adamson's presentation, a panel discussion was held on how automation can be adapted to motion-picture problems in the sound departments, laboratories, special effects departments, and other phases of motion-picture production and exhibition.

The panel consisted of Norwood L. Simmons, Moderator; Gordon E. Sawyer; John P. Livadary; Sidney P. Solow; Harlan L. Baumbach; Ub Iwerks; and L. B. Abbott.

Each of the panel members gave briefly his understanding of the influence which automation might have on the functions of his particular department in a studio or laboratory. An attempt was made to explore the ways in which automation can help the industry. If it is arbitrarily assumed that automation must do a job better, faster, or cheaper, then if at least one of these three objectives is not achieved there is no logic in attempting to foist any of the processes covered by the term "automation" on motion-picture production management. It is highly questionable whether automation has a place in many of the departments in a motion-picture studio. It is believed that efforts at automation in some departments have resulted in higher costs to studios. What is most needed is a fair appraisal of this latest offspring of our permanent industrial revolution.

Some examples of possible uses for automation that were explored by the panel are:

(1) The use of automatic focusing devices in motion-picture projection. By feedback of sharpness information a theater projector could be made self-focusing. There is a great need for this today with the strains which wide-screen processes have imposed on the film and the optical characteristics of a motion-picture projection system.

(2) A storage device could be made to program the printing or projecting (optical printing) of a negative which must be cropped unsymmetrically, scene to scene, because it was produced or photographed at one aspect ratio and will be projected at another. Such a negative could be programmed on a punched card or storage device, and then release-printed automatically.

(3) The need for monitoring light output in printers, and in any other equipment that relies on constancy of illumination, is great. Automation in the simple sense of feedback devices could be put to work here.

(4) Automatic editing devices were discussed at some length. Experience with these devices has pointed up the fact that motion-picture production is not an assembly-line operation and this form of automation may be used correctly only in select cases.

(5) Some devices, such as automatic titrators and automatic flow-control devices, are in use now in motion-picture laboratories for chemical control.

One challenge to the automation experts is "product inspection," which has been called "astonishingly unmechanized." In the motion-picture industry product evaluation is mechanized by the use of loudness meters to measure laughter and other audience reaction at previews. This is a very simple instance. Thus far, there has been no successful method devised for mechanizing film inspection in a laboratory. The presence of scratches and unwanted spots can not be distinguished, by integrating devices or other mechanical control devices, from the subject matter itself.

A few quotes from the meeting:

"Automation ranges from coffee-vending machines to intercontinental missiles."

"It has been said that to use a high-speed digital computer in order to centralize all control features of certain processes, such as oil refining, under the present conditions of instrumentation and chemical understanding, would be like using a Cadillac to move trash. Can this statement be applied likewise to an effort to mechanize motion-picture production at the present time?"

"A servomechanism, an element of a closed-loop control system, is a sort of mechanical muscle."

"There have been Congressional hearings which have resulted in vague warnings that automation may upset the economic balance of our industry."

"Fans of 'automation' have been anticipating an early return to The Garden of Eden, where man got his living without a sweaty brow."

The moderator concluded the panel discussion with the following statement:

"A picture of the future as influenced by automation, and as has been drawn by some experts in the field, would be as follows: Fewer men will stand behind machines. More maintenance men will be needed than heretofore. Also, since automatic machinery will do only what it is told to do, it will always have to be programmed. (Boeing engineers call high-speed computers 'supersonic morons.') The emptier the factory floor becomes, the more crowded the computing room, the laboratory, the engineering department. This trend will require a broadening and deepening of the entire educational system. It will, we hope, liberate man from routine tasks and give him more time for the creative enjoyment of life."—*Norwood L. Simmons*, Moderator, c/o Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38.

**The San Francisco Section** met December 11 at the Stanford Research Laboratory with an attendance of 20. Four experts dis-


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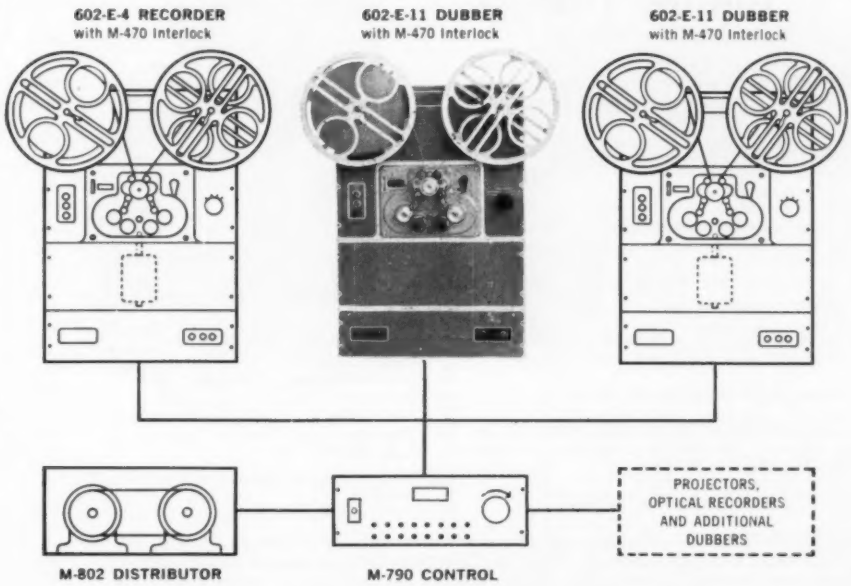


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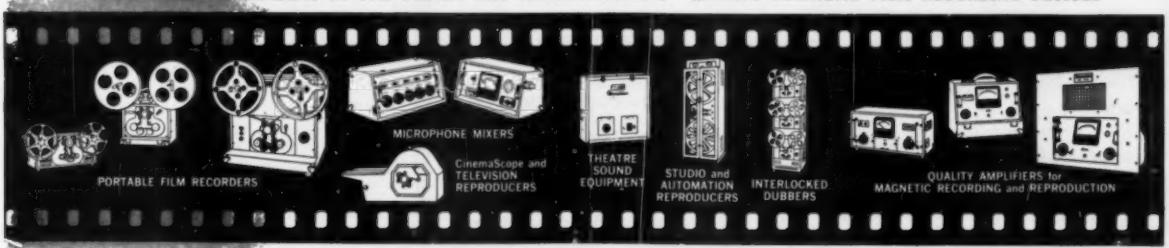


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cussed the subject of "Electrostatic Duplicating," a promising new technique for recording pictures and printed matter having an ultimate resolution capability comparable to that of slick magazines (120 lines/in. or 1800 lines TV resolution). The speakers were Dr. Philip Rice, William Evans, Howard Bordon and Wayne Crewes, all of the Electronic Devices Lab. at the Stanford Research Institute. This system will be capable of reproducing three 8½ × 11 in. sheets of paper each second, or for computer use it is capable of read-out speeds of 10,000 characters each second. It utilizes a unique cathode-ray tube having closely spaced wires sealed into its face in a straight line. The ends of the wires are charged by an electron beam which can be modulated with video information. Treated paper moving across the face of the tube acquires a charge pattern which in turn collects finely divided powder or dye. The resulting image can be permanently fixed. This device was developed for the A. B. Dick Co. for a high-speed duplicator not requiring a master. Its ultimate usefulness will probably transcend this application since it is the highest speed facsimile system known to be under development—*R. A. Isberg*, Secretary-Treasurer; Consulting Television Engineer, 2001 Barbara Dr., Palo Alto, Calif.

**The San Francisco Section** met January 15 at the Walter Ball Film Labs with an attendance of 27. Speakers were W. A. Palmer of W. A. Palmer Films, Inc., who told of the early work of Walter Ball. Joe Rucker, a freelance newsreel camerman, told of his experiences during 45 years as a newsreel cameraman. The meeting was planned to honor those men who have been active in the field of motion-pictures since the early days.

Mr. Palmer showed a film, produced by him, which traced the history of motion-picture photography in the San Francisco area. Depicted in the film were the early works of Walter Ball, C. R. Skinner and the speaker. He also displayed a 35mm camera made by Ball about 1910. The 45-year-old camera is still in perfect operating condition and is equipped with the latest mattes such as the diamond shape, binocular, and the keynole shape. He also described processing machines, mike booms and printers invented or developed by Ball.

Joe Rucker who, as he said, "worked in the theatrical newsreel game from its start to finish," has covered major news events throughout the world. He covered Admiral Byrd's first expedition to the South Pole, the Ford Peace Mission to Europe in 1915, the opening of the Panama Canal and other important events.

After the meeting, Mr. Ball conducted a tour through his processing laboratories and machine shop where he displayed an unusual animation stand he had built.—*Werner H. Ruhl*, Secretary-Treasurer, 415 Molimo Dr., San Francisco 27.

**The Rochester Section** met January 17 at the Dryden Theater, Eastman House, Rochester, N.Y. Robert Shoberg, Wollensak Optical Co., gave an historical résumé of the development of rotating prism cameras for motion-picture photography and concluded his talk with two 16mm sound

films which displayed the versatility of these cameras. The address was followed by an informal discussion. Thirty three persons were present, the comparatively small attendance being attributed to the sub-zero weather that on the date of the meeting broke a 25-year record.—*A. E. Neumer*, Secretary-Treasurer, 147 Dale Rd., Rochester 10, N.Y.

**The Chicago Section met** December 13 at the Prudential Building with an attendance of 35. The meeting was opened with a film, *The Chicago Tribune All Star Game*, produced by Douglas Productions, Chicago, and narrated by Jack Brickhouse.

The first paper, "A 16mm Process Control Sensitometer," was presented by George Colburn, Geo. W. Colburn Laboratory, Chicago. This paper described a sensitometer of the intensity-scale type, exposing a full 16mm frame for each step. The instrument can be used with black-and-white or color film. A model was available for inspection. The second paper, "A Transmission-Reflection Color Densitometer," presented by John A. Maurer, W. M. Welch Scientific Co., Chicago, described a new process control densitometer for measuring full-frame 16mm or 35mm areas. A model of the instrument was available for inspection.—*H. H. Brauer*, Secretary-Treasurer, c/o Bell & Howell Co., 7100 McCormick Rd., Chicago, 45.

**A Canadian Section** of the Society of Motion Picture and Television Engineers was authorized by the Board of Governors at the meeting held at New York, January 25, following presentation of a petition to the Board from members living in Canada. The new section, with headquarters in Toronto, will hold its first technical meeting following completion of the organizational arrangements, and will include 180 members now living in Canada.

In addition to approval of the Canadian Section, the Board authorized the establishment of two new student chapters, one at City College, New York, and the other at the Rochester Institute of Technology. The new chapters are under the direction of Faculty Advisors Martin Rich (CCNY) and Hollis Todd (RIT). The Society has at present a student chapter at New York University and a chapter at the University of Southern California.

**A survey conducted by the Engineers Joint Council** shows that salaries of engineers have generally lagged and are not keeping much ahead of the pay of industrial workers, carpenters, plumbers and bricklayers. The Council, representing 13 engineering societies, conducted the survey covering the salaries of 93,000 engineers. Data were obtained mainly from the payroll records of 350 companies. Prof. Edward B. Peck, Rutgers University, presented an analysis of the data to the Council at a meeting held January 17 at the Statler Hotel, New York. The report showed that a typical engineer in mid-career earns $10,000 a year, but if his salary had kept pace with industrial increases since 1939, he would be earning $16,000. "This is not an attractive return on the investment for an engineering education," Dr. Peck observed.


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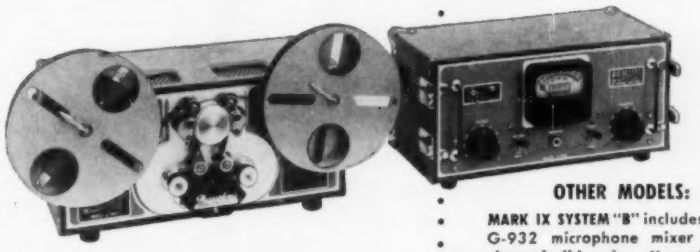

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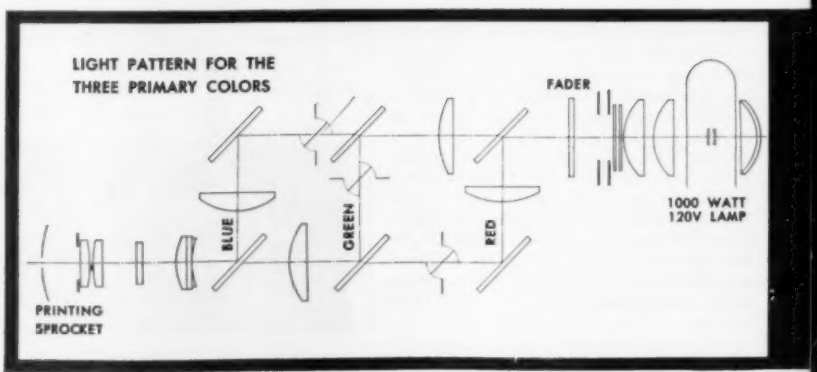
*For further information, write Bell & Howell, Professional Equipment Division, 7185 McCormick Road, Chicago 45, Illinois.*



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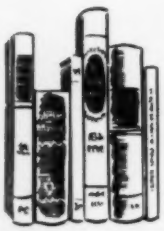


## books reviewed

### Mathematics for Electronics With Applications

By Henry M. Nodelman and Frederick W. Smith. Published (1956) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. 360 pp. + 14 pp. appendix + 14 pp. index, Illus. 6 × 9 in. Price $7.00.

As its title implies, this book is intended primarily for the study of certain topics in mathematics which are useful in the analysis of problems arising in electronics. Most of the material, therefore, applies to only one part of the field of motion-picture engineering. However, much of the theory is of general interest, since it is applicable to broader problems of the motion-picture art.

There are some sections and problems which relate to specific phases of the motion-picture field. One section and problem both concern disk recording, one section illustrates an application of the theory to luminance problems, and a problem concerns an acoustics application, that of loudness-weighting equalization. These, however, constitute only a fraction of the total volume. Thus, although the book is specifically useful in some cases, it might not be one to which the motion-picture engineer would normally refer for general information.

For the field of electronics, however, the book represents a different and refreshing approach to higher mathematics — that of "learning by doing." For the person who has, in the words of the authors, "a background of elementary calculus, physics, and elementary network theory," it helps to bridge the very important and often neglected gap which exists between the mathematical theory as presented in most textbooks, and the application of this theory to the solution of practical problems. In place of carefully rigorous proofs often found in mathematics textbooks, practical problems are numerically solved to illustrate the methods of solution. In many cases, these problems serve as proofs.

The presentation of information is, on the average, extremely good. The inherent drawback to the "learning by doing" method, that of learning to solve only specific problems, is to a great extent overcome by the wealth of different types of problems presented.

The subject material includes dimensional analysis, determinants and matrices, Taylor series, and Boolean algebra. One serious omission is the lack of any discussion of Fourier Series. On page 360 this topic is rated higher in importance than such topics as Laplace Transforms and Matrix Algebra. However, although the latter subjects are covered in some detail, only a few references are made to Fourier Series and Fourier Transforms, and nowhere are the general Fourier Series expansion formulas given. Also, the extension of the determinant theorem 5-7B on page 90 is not valid, and equation 5–45 on page 91 is therefore in error.

Although these drawbacks, particularly the omission of the Fourier technique, reduce the value of the book, the material is well arranged and provides the student with the often-lacking motivation for study.

In conclusion, the lack of problems pertaining to the motion-picture field makes the book of only general interest to many motion-picture engineers, but electronics and television engineers should find it interesting and useful.—*Harvey W. Mertz*, TechRep Div., Philco Corp., Tioga and C Sts., Philadelphia 34.

### Lenses in Photography

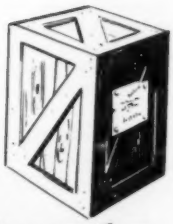
By Rudolf Kingslake. Published (1951) by Case-Hoyt Corp. for Garden City Books, Garden City, N.Y. 246 pp. Illus. 8¼ × 5¼ in. Price $2.95

(*Edit. Note: Through no fault of the present reviewer, this book has far too long awaited attention in the Journal.*)

The inquiring cameraman who wants to know how and why one lens differs from another frequently lacks mathematics. Without this background to study advanced texts, he may find little of substance in popular articles to answer his questions. This is the man to whom Mr. Kingslake's book is addressed.

The book contains much of factual content, even for the man who has sufficient mathematics to follow advanced texts, and is presented in easily understood language. Terms are precisely defined and terminology is consistent throughout the text. Well-conceived illustrations demonstrate very effectively such lens defects as different types of distortion, coma, ghost images and flare. The story on types of photographic objectives provides good historical background. Motion-picture taking and projection lenses are adequately covered. A bibliography is included for more detailed background when required. Coverage is not confined to lenses, but includes such material as screens, viewfinders, shutters, condensers used in projection, stereoscopy and perspective.

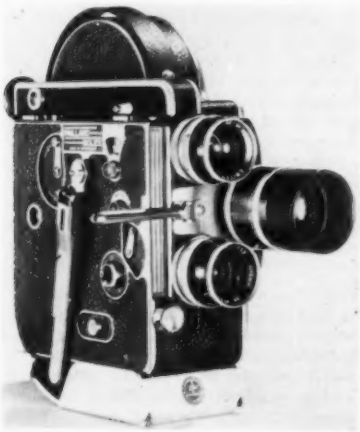
Where mathematical terms or formulas are used, their significance is explained by diagrams or photographic illustrations. Thus, in entering into a discussion on specular and diffuse densities of an emulsion (a point ordinarily avoided in cursory popular treatments), the author provides simple diagrams which make the technical content clear and interesting. This material follows and emphasizes a related discussion on reflection from projection screens. Through such treatment, the reader is easily introduced to a gratifyingly wide range of subject matter. In this reviewer's opinion, the book is a masterpiece of clear, simple writing.—*Bernard D. Plakun*, General Precision Laboratory Inc., Pleasantville, N.Y.

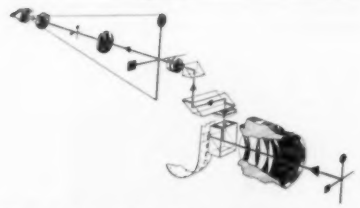


# new products

## (and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.





**The Bolex H-16 Reflex,** a product of Paillard Products, Inc., 100 6th Ave., New York 13, represents a further development of the company's H-16 Cameras in the area of viewing and focusing. In this camera the image is picked up behind the lens in front of the shutter by a semi-reflecting prism, and can then be viewed right side up and six times enlarged from behind the camera through the eye-level focus. The eye-level focus is equipped with an adjustment for various eyesights. The new camera requires specially designed lenses, also produced in Switzerland, because the reflex prism affects the optical correction of short focal length lenses. The special lenses are engraved RX on the barrel to distinguish them from the regular line of Kern-Paillard 16mm lenses. Prices for the Bolex H-16 Reflex range from $419.50 to $535.50, depending upon the lens.

**A new model of the Line Densitometer** has been produced by the Baldwin Instrument Co., Brooklands Works, Dartford, Kent, England. The instrument is basically a transmission densitometer with special

facilities for accurately locating the sample under test, it was originally designed for measuring density of soundtracks on 35mm film. With the new model, all sizes of motion-picture film can be tested for both density and color analysis.

The optical unit of the densitometer comprises a tungsten filament lamp which illuminates, by means of a lens system, the sample under test. The light passes through the sample and is projected onto the photocell through the defining aperture and color filters if required. The instrument is reported to have an accuracy of 0.02 up to density 3 and 0.02 to 0.1 for densities between 3 and 4.

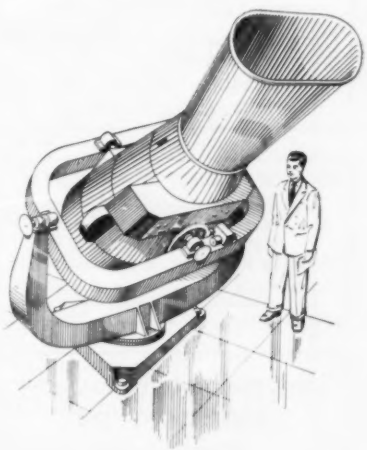
The output from the vacuum photocell is fed into a highly stable d-c amplifier the output from which is indicated on a moving coil meter. A 3-position switch enables the selection of the appropriate density range. A desirable feature is the linearity of the density scale.

**Color Television Incorporated** has been renamed California Technical Industries but the CTI registered trademark remains unchanged. The firm was organized to develop and promote a line-sequential system of color television, but its activities in this field ended five years ago when the Federal Communications Commission designated another type of color system as the national standard. The firm recently moved from San Carlos to Belmont, Calif. Its chief products are specialized test instruments for the electronic, aircraft and missile industries.

**A single-cable Industrial Television Control System** which combines both visual observation and remote control throughout a plant over a closed-circuit television system, has been introduced by the Jerrold Electronics Corp., 23d and Chestnut Sts., Philadelphia 23. One use of the system is that of protection. For example, a watchman can scan the faces of visitors or employees on a TV screen and examine identification from a considerable distance, while opening or closing the gate by means of a remote-control switch. This system is reported to carry all functions, 2-way communications, 2-way pictures and remote control over a single coaxial cable.

**The Optical Industry Directory** has just been issued for 1956–57 by the Optical Publishing Co., Huntington, N.Y. The 307-page *Directory* lists American and foreign manufacturers and distributors of optical supplies and equipment. The names of more than 300 companies have been added to those appearing in the previous issue. The *Directory* also contains a list of optical products and services and an area listing of the companies that supply the items. One of the new sections lists the names, titles, affiliations and specialties of industry personnel. The *Directory* is available from the publishers and is priced at $5.00.

**Complete sound studios** and other rental services are described in a new brochure from the Rolab Photo-Science Laboratories, Sandy Hook, Conn. Located on Connecticut's Routes 6 and 202, the sound stage building is one mile from the state highway. Studio rental per day, including electric current from 9 A.M. to 6 P.M., is $60.00. The rental includes complete lighting equipment. Also available are cameras including Cine Specials, Arriflex, Mitchell, DeVry, Debrie Parvo and Bamberg-Ascania at rentals ranging from $7.00 to $25.00 a day. The laboratories are equipped for chemical, biological, industrial and general experimental work.



**Twelve special cameras,** with one of the most difficult-to-produce optical systems ever attempted, will soon go into production for a unique task — that of photographing an object the size of a basketball traveling at twice the speed of sound 250 miles distant.

The object is the earth satellite to be launched during the coming International Geophysical Year. The 10-ft cameras will be placed in carefully selected locations throughout the world to photograph the man-made satellite at various points in its orbit. Two of the cameras will be set up in the United States, one at White Sands Proving Grounds, N.M., and the other at Patrick Air Force Base, Fla.

The production of the optical system for the cameras is being undertaken by the Perkin-Elmer Corp., Norwalk, Conn. Dr. James Baker, President of Spica, Inc., designed the 20-in. aperture, ultrafast $f/1.0$ apochromatic lens for the camera. The cameras have a 30° field of view. The lens design calls for three aspheric corrector plates with a total of four aspheric surfaces

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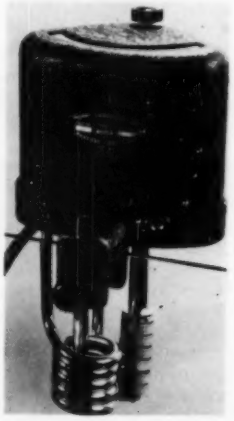
and a 32-in. mirror. The mechanical portion of the cameras has been designed by Joseph Nunn and Associates, Los Angeles, and will be manufactured by Boller and Chivens, Pasadena, Calif.

**A 3.45mm wide-angel lens** designed for compactness has been announced by Traid Corp., 17136 Ventura Blvd., Encino, Calif. Known as the Traid 720, the lens covers an area 165° both horizontally and vertically and is available either in a gun camera mount or a C mount. It is equipped with an iris ring adjustment from *f*/1.5 to *f*/8.0. With the gun camera mount, the lens protrudes 4½ in. from the front plate of the camera and measures 4 in. in diameter at its widest point.

**Traid Corp.** has announced the opening of its new plant at 17136 Ventura Blvd., Encino, Calif. The new structure is of modern design, built around an open patio with a reflector pool. All the offices have outside windows. In addition to showrooms and offices the plant provides facilities for engineering activities, especially in the fields of research and development.



**Arthur S. LaPine & Co.,** 6001 S. Knox Ave., Chicago 29, is distributing a new apparatus for operating laboratory water baths, manufactured by Techne (Cambridge) Ltd., Duxford, England. The case dimensions of this compact unit are 5½ × 4½ × 3½ in. and the overall length is 10 in. It weighs 5½ lb and is attached to any size container by a rubber-cushioned clamp. It acts as heater, controller, stirrer and circulator with a built-in pneumatic control system sensitive to within ±0.05 C.

**These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.**

## Positions Wanted

**Administrative Engineer.** The SMPTE's Staff Engineer, Henry Kogel, is seeking a new position, after 6 years working with SMPTE Engineering Committees and the motion-picture standards program; also serving as Secy, American Standards Assn. Sec. Committee PH22, and Tech. Secy, International Standardization Orgn. Tech. Com. 36, Cinematography; 2 years, previously, develop. engr. with Sperry Gyroscope Co.; B.S. Elec. Eng., Columbia Univ., 1948, after military service as radio off.; age, 37; married; N. Y. area pref.; complete résumé upon request—Henry Kogel, 19–24 202 St., Bayside 60, N. Y.; Tel. BAyside 9-3574, or at SMPTE, LOngacre 5-0172.

**Photographic Development Engineer.** Freelance or consultation. Long experience in design, development and production engineering of both military and commercial motion-picture and still cameras and projectors, enlargers, film editors, lapsed time and sequence cameras, viewers, automatic aperture controls, stereographic, press cameras, etc. Military and commercial references available on request. Write: P.O. Box 601, Jamaica 31, N.Y.

**Apprentice Film Editor.** Seeks summer position. Currently cinema student at CCNY; previously at UCLA with top grades. Meyer Odze, 1669 Macombs Rd., Bronx 53, N.Y.

**Motion Picture and Television Production** December graduate of Television Workshop; thorough knowledge of film and television techniques, including film transmission equipment, kinescope recording, optics, film markets, library methods. Specialty film genealogy, set lighting and decorating, and electrical effects. Currently secretary of the Society of Cinema Collectors and Historians. Age 33, married. Résumé on request. Larry Morales, 37-16 55th St., Woodside, N. Y.

**Laboratory Engineer.** Over 10 years in design, procurement and co-ordination of plant, printing, developing and auxiliary equipment. Esp. interested in film sequence-of-operation planning or similar industrial engineering function in sympathy with MIT degree and experience. Position might be with a lab, producer, ad agency, or TV facility. Fred Bray, 40 Ryerson Place, Closter, N.J. Closter 5-1766J.

## Positions Available

**Sales Engineer** for sound-on-film 16mm cameras. Start $6,600/yr with opportunity for advancement with established company; this is our 26th year in business, see our ads in your SMPTE Journals. To work in Hollywood office with Sales Manager, handle customers and answer mail, covering sales and service of Auricon 16mm sound-on-film optical and magnetic recording cameras. Technical knowledge of, or experience as 16mm producer, professional cameraman, soundman, or both, is necessary. Also ability to write good technical letters. Send résumé, with references, to: Walter Bach, Berndt-Bach, Inc., 6900 Romaine St., Hollywood 38.

**Aerial Photographic Technician** sought to take motion pictures and still photographs of equipment under aerial test. Must be experienced in installation and alignment of aerial cameras, familiar with wiring and control circuits, and be able to operate and trouble shoot aerial camera wiring. Capable of performing laboratory work to produce photographs and records obtained from motion-picture and still cameras and photorecorders, and of supervising all aerial photographic activities. Relocation expenses paid; excellent salaries and working conditions; advancement by merit; company-paid benefits. Write qualifications and experience to: Mr. A. J. Page, Department 334, Personnel Administration, IBM Corporation, Airborne Computer Laboratories, Owego, N.Y.

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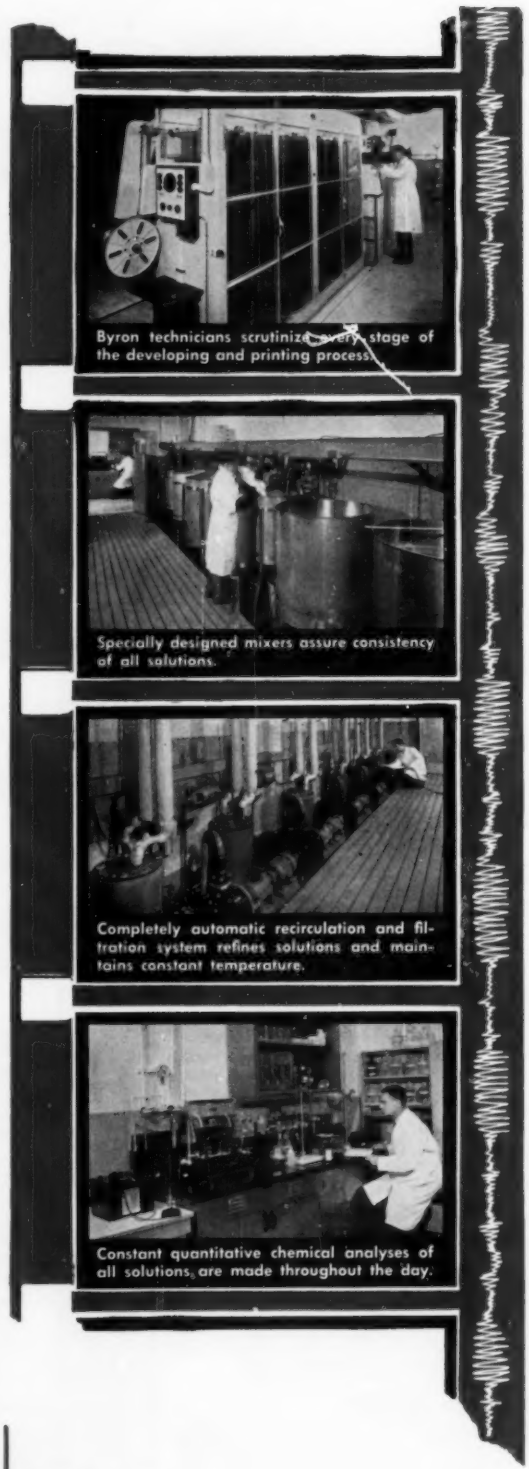

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### Meeting Calendar

National Photographic Show, Feb. 16–24, New York Coliseum, New York.
American Society of Civil Engineers, Annual Convention, Feb. 18–22, Hotel Heidelberg, Jackson, Miss.
Deutsche Kinotechnische Gesellschaft, Mar. 7–9, Technical University, Berlin, Germany.
Inter-Society Color Council, 26th Annual Meeting, Mar. 7, Statler Hotel, New York.
Optical Society of America, Mar. 7–9, Statler Hotel, New York.
1957 Nuclear Congress, Nuclear Engineering and Science Conference, Mar. 11–14, International Atomic Exposition Mar. 11–15, Hot Laboratories and Equipment Conference Mar. 14–15, Atomic Energy in Industry Conference Mar. 14–15, Convention Hall, Philadelphia.
Radio Engineering Show and IRE National Convention, Mar. 18–21, New York Coliseum, New York.
Military Automation Exposition, Mar. 18–21, Trade Show Bldg., New York.
American Physical Society, Mar. 21–23, U. of Pennsylvania, Philadelphia, Pa.
International Photographic Exposition, Mar. 22–31, National Guard Armory, Washington, D. C.
American Institute of Electrical Engineers, American Society of Mechanical Engineers, Engineering Management Conference, Mar. 27, 28, William Penn Hotel, Pittsburgh, Pa.
American Rocket Society, Spring Meeting, Apr. 3–5, Washington, D. C.
American Chemical Society, Apr. 7–12, Miami, Fla.
National Electrical Industries Show, Apr. 8–11, 71st Regiment Armory, New York.
Armour Research Foundation, Institute of Radio Engineers, Conference on Electronics in Industry, Apr. 9, 10, Illinois Institute of Technology, Chicago.
National Academy of Sciences, Apr. 22–24, Washington, D. C.
Symposium on the Role of Solid State Phenomena in Electric Circuits, Polytechnic Institute of Brooklyn, Apr. 23–25, Engineering Societies Building, New York.
Armour Research Foundation, National Industrial Research Conference, Apr. 24, 25, Conrad Hilton Hotel, Chicago.
American Physical Society, Apr. 25–27, Washington, D. C.
Institute of Radio Engineers, Annual Spring TV Conference, Apr. 26, 27, Engineering Society Bldg., Cincinnati, Ohio.
**81st Semiannual Convention of the SMPTE, including Equipment Exhibit, Apr. 29–May 3, Shoreham Hotel, Washington, D. C.**
Electronic Components Symposium, May 1–3, Morrison Hotel, Chicago
Acoustical Society of America, May 23–25, New York.
American Society for Testing Materials, June 16–21, Chalfonte-Haddon Hall, Atlantic City, N. J.
American Institute of Electrical Engineers, Summer General Meeting, June 24–28, Montreal, Que.
International Symposium on Physical Problems of Color Television, sponsored by International Union of Pure and Applied Physics, French Physical Society, French Society of Radioelectricians, French Society of Vacuum Engineers, July 2–6, National Conservatory of Arts and Crafts, Paris.
Western Electronic Show and Convention, Aug. 20–23, Cow Palace, San Francisco.
**82nd Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 4–9, Philadelphia-Sheraton, Philadelphia.**
National Electronics Conference, Oct. 7–9, Hotel Sherman, Chicago.
**83rd Semiannual Convention of the SMPTE, including Equipment Exhibit, April 21–26, 1958, Ambassador Hotel, Los Angeles.**
**84th Semiannual Convention of the SMPTE, Oct. 20–24, 1958, Sheraton-Cadillac, Detroit.**
**85th Semiannual Convention of the SMPTE, including International Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach.**
**86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 6–10, 1959, Statler, New York.**

**SMPTE Officers and Committees:** The rosters of the Officers of the Society, its Sections Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1956 Journal.

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